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Archaeological Inventory and Predictive Modelling in the Pacific Northwest

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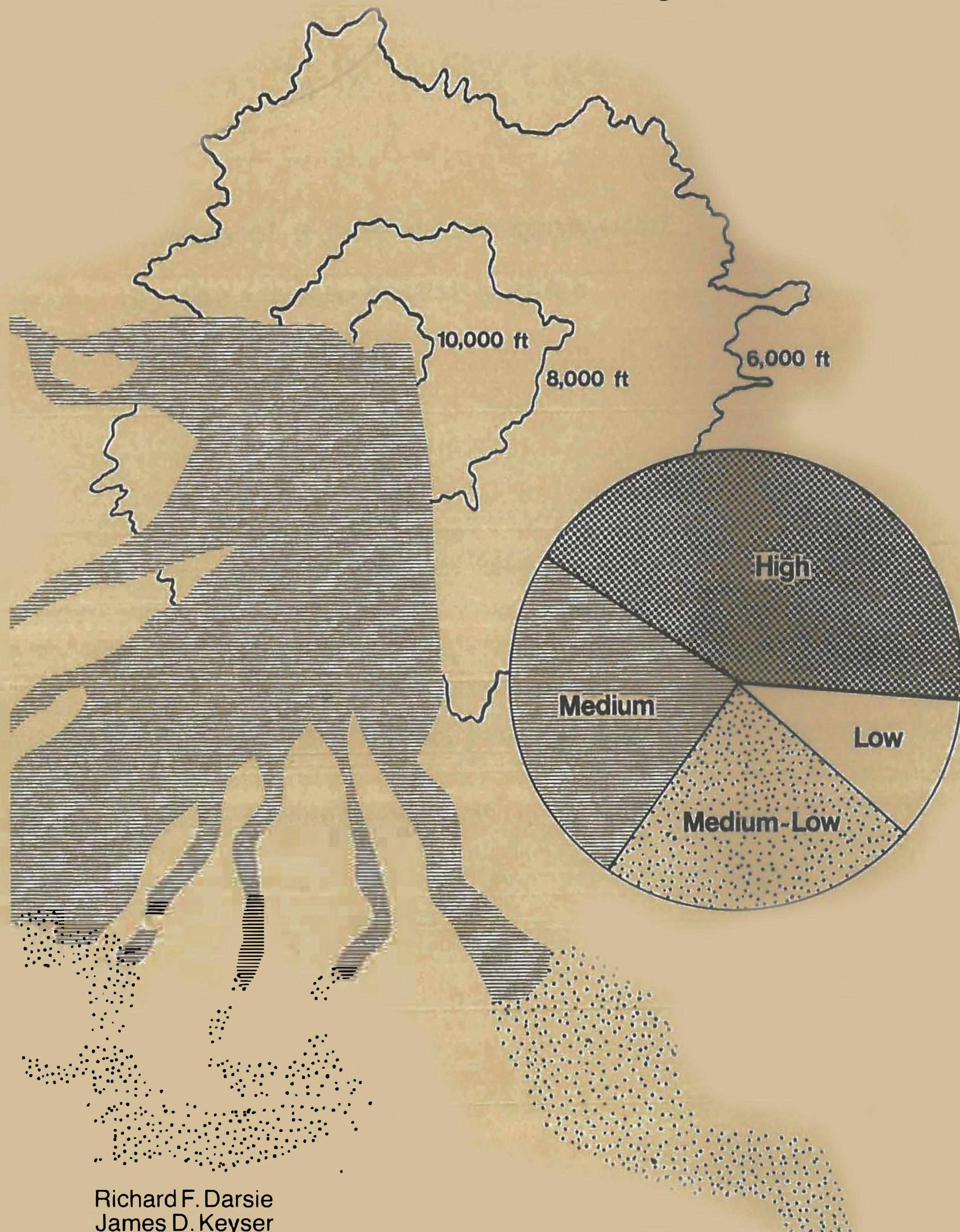

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ARCHAEOLOGICAL INVENTORY AND PREDICTIVE MODELING IN THE PACIFIC NORTHWEST

Proceedings of a conference sponsored by the USDA-Forest Service

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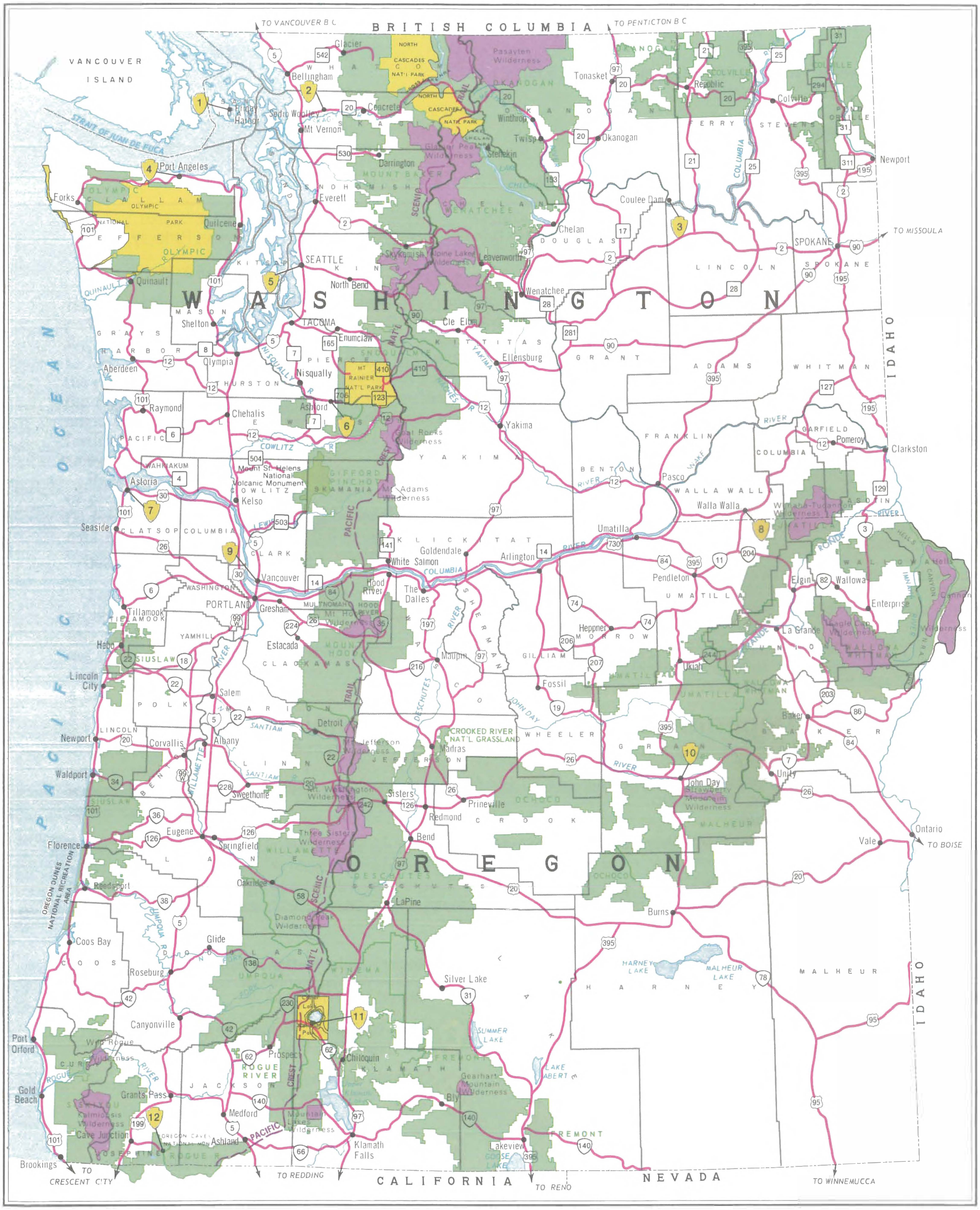

NATIONAL FOREST	U S HIGHWAY
NATIONAL FOREST WILDERNESS	INTERSTATE HIGHWAY
MOUNT ST HELENS NATIONAL VOLCANIC MONUMENT	OREGON STATE HIGHWAY
NATIONAL PARK	WASHINGTON STATE HIGHWAY
NATIONAL PARK SERVICE HEADQUARTERS	COUNTY LINE
	PACIFIC CREST NATIONAL SCENIC TRAIL

NATIONAL FORESTS and NATIONAL PARKS
of
PACIFIC NORTHWEST

U S DEPARTMENT OF AGRICULTURE FOREST SERVICE – 1984

MANAGEMENT SUMMARY

This publication represents proceedings of a conference devoted to archaeological inventory and predictive modeling in the Pacific Northwest, sponsored by the USDA-Forest Service, Region 6, at the Washington Archaeological Research Center in Pullman, Washington, from January 28 to February 1, 1985. The conference brought together Forest Service, academic, and contract archaeologists for the purpose of exploring issues relating to inventory and predictive modeling as currently practiced in the Pacific Northwest, and providing suggestions and recommendations as to how current practice might be improved. Key themes in the conference were cost-effectiveness and the maintenance of professional responsibility to the resource.

Papers presented at the conference are grouped thematically in this document rather than in order of presentation. The four themes are (1) issues in archaeological inventory and locational modeling, (2) Forest Service inventory and locational site models (with comments), (3) computerized geographic data management and its potential as an aid to archaeological inventory, and (4) proposed research involving inventory and predictive modeling.

Following presentation of the individual papers, the conference participants formed three "working groups" whose goal was to formulate specific recommendations to the Forest Service on how its inventory program might be improved. Three specific areas were utilized as a means of focusing the working group effort: (1) in-field survey activity, (2) inventory sampling design, and (3) predictive locational modeling. Each working group addressed all of these issues, and during the course of a day and a half of discussion produced summary documents. These are printed as the "Working Group Documents" section of these proceedings.

Following preparation of the summary documents, each working group presented its recommendations to the entire conference, and a general round table discussion followed in which the issues raised were discussed in detail. Some of the general tenor of this session is conveyed in the final section of this document.

At the conclusion of the conference the participants agreed that it had provided an opportunity for various sectors of the archaeological profession to interact and share ideas. Additionally, some valuable contributions were made toward understanding the current situation and the necessary future directions for archaeological inventory in the Pacific Northwest.

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ACKNOWLEDGEMENTS

The USDA-Forest Service expresses its appreciation to the Washington Archaeological Research Center (WARC) for its role as conference host. WARC, as an interinstitutional organization, is uniquely suited for involvement in the type of cooperative archaeological endeavor exemplified by this conference, and for helping make the results available to a wider audience. The contributions of Steven Hackenberger, former WARC assistant director, in helping to organize the conference and in acting as conference moderator along with James Keyser, deserve special mention. We thank Dr. Dale Croes, WARC director, for introducing the conference and providing his program staff to help coordinate aspects of the conference as well as the preparation of this publication. Finally, we are grateful to the participants, who had the courage to travel to Pullman, Washington in January, and whose active involvement contributed much to the success of the conference.

INTRODUCTION

James D. Keyser
Region 6 Archaeologist

The United States Forest Service began administering the Forest Reserves (now National Forests) in 1905 as an agency in the Department of Agriculture. There are now nearly 25 million acres on 19 National Forests in the Pacific Northwest states of Washington and Oregon. For these National Forests, the region has a congressionally appropriated budget of 475 million dollars. This money funds a wide variety of programs; timber management is the largest, with 5 billion board feet harvested from 600,000 acres each year, but other programs are also significant. For instance, 2,000 miles of roads are built every year, 800,000 animal unit months of grazing are permitted, and recreationalists spend more than 30 million visitor days each year on these forests. In summary, the Forest Service is big business; so big, in fact, that the natural resources of this one region would place us in the top third of the Fortune 500 if we were so ranked.

The business of the Forest Service is a combination of commodity production (e.g., board feet, recreation visitor days), protection of amenities, and land stewardship—wilderness areas are administered, wildlife habitat is improved, cultural resources are inventoried and protected, trails are constructed, and water quality and forage are maintained and enhanced. Gifford Pinchot, the founder of the Forest Service, summarized it this way:

> ...all land is to be devoted to its most productive use for the permanent good of the whole people...where conflicting interests must be reconciled the question will always be decided from the standpoint of the greatest good of the greatest numbers in the long run. (Bergoffen 1976:28; Steen 1976:75).

Inevitably, however, these agency missions clash, and resource conflicts arise. The best use of one parcel of land from the perspective of one resource (e.g., timber management) may not be the best use from other resource perspectives (e.g., cultural resource values).

When this conflict occurs, decisions are based on criteria of the greatest good. Timber does not always prevail—we have avoided thousands of cultural resource sites in the past ten years. We have also excavated numerous sites and mitigated impact to others through a variety of logging system and construction design changes.

Inventory—the subject of this conference—is a key element in the Forest Service cultural resource program. We know that National Forest System lands contain many sites, and we must locate these in order to manage and protect those that are of value. As an agency, the Forest Service is no stranger to inventory. It has a long history of inventorying many different resources. Timber inventory began before 1920, and grazing allotments were first inventoried between 1910 and 1915. Even some cultural resources were the subject of early inventory efforts, as indicated by a 1906 letter from Gifford Pinchot that instructs Forest Officers to report upon each ruin that might be proclaimed as an Historic Landmark under the Antiquities Act (Pinchot 1906). So, inventory is something the agency understands; the only constraints it places on our efforts are that inventory be cost-efficient, resource-oriented, and focused on the projects that compose our funded targets.

The 19 National Forests in the Pacific Northwest Region have been actively inventorying cultural resources for nearly a decade. During this time, considerable money and effort have been devoted to locating and recording more than 13,500 archaeological and historical properties. Concurrently, 20 percent of the region's 25 million acres has been intensively surveyed. Until recently, however, what has been lacking is a planned effort to use this data base—the accumulated knowledge of settlement patterns, site densities, and site significance—to increase the reliability of our survey effort. Only in the last three years have we begun to formally design inventories based on predictions as to the probability of cultural resources occurring in various environments. From this beginning came the Cultural Resource Inventory Plans now in use on or being developed for most of the region's forests.

Concurrent with our effort in the Pacific Northwest to develop more archaeologically meaningful inventory strategies, the Forest Service Washington Office began evaluating the national cultural resource management program. One finding of this evaluation is that across the country cultural resource inventory is neither as cost-effective nor as resource-oriented as desired. In the process of doing our legally mandated inventory job, many thousands of resources are being located and information is being accumulated, but little effort is being spent in using these data or in planning uses to which they will be put.

Since a complete inventory of all national forests will require several more decades, this cultural resource inventory approach, where data are merely recorded and stored, has a very high cost (approximately 9 million dollars per year) with very little return that is of value in managing these sites. Additionally, there is a significant risk that we may finish the job only to discover that the collected information meets neither the agency's nor scientific needs, or that much of it was redundant and need not have been collected. In light of this high cost/low return program, the concern of both land managers and cultural resource specialists is easily understood.

In an attempt to build upon efforts already begun in various regions of the Forest Service, the Washington Office initiated a program to sponsor conferences such as this one in several different areas of the country. The purpose of such conferences is to summarize the state-of-the-art in regional cultural resource inventory as a basis for streamlining and improving Forest Service inventory efforts.

In the Pacific Northwest Region, we view our Cultural Resource Inventory Plans as a starting point for this summarization. These plans are a significant advance in our agency's survey methodology since they clearly document our approach, are replicable, and have a built-in mechanism for monitoring their effectiveness, but we recognize that they are only a starting point. Their weakest aspect is the intuitive nature of the predictions, coupled with the paucity of survey data available from outside National Forest boundaries (much of the survey which has been done outside the forests is fractional and unpublished and, therefore, essentially unavailable to us). Additionally, national forest management, unlike research-oriented institutions, is production oriented and project-driven. Whether it be animal unit months, miles of fence, recreation visitor days, or board feet, there are targets, and appropriations are attached only to targets. For cultural resource management, the primary target is inventory of the approximately one million acres per year that are scheduled for ground disturbing activities (e.g., timber sales, road building). Our job is to do good, cost-effective inventory of these one million acres so we can protect sites. Efficiency means more coverage, and coverage of logical land units rather than a patchwork of segregated impact areas. We must rely on academic institutions and consultants for data not within our boundaries and for many of the technical and methodological advances that will enable us to do a more complete and cost-efficient job. Thus, we felt that it would benefit both the agency and the broader archaeological community to interact in this session and share concerns, insights, problems, and solutions to the cultural resource inventory issue. Our concerns for cost-effective target accomplishment blended with research interests in the theoretical study of inventory premises, and sophisticated cultural models should lead us to a stronger program. We also can share the accumulated Forest Service data base, and hopefully increase the validity of our inventory sampling efforts.

Ideally, one result of this conference will be a better predictive modeling approach for cultural resource inventory than is now available. Such modeling fits very comfortably in the Forest Service land management planning process—a mechanism by which resource potentials of the land are assessed to indicate a preferred land management strategy. We expect that predictive modeling and increased cultural resource inventory planning will become an important aspect of an integrated program of cultural resource management. As a planning tool, this effort should increase efficiency of finding sites and therefore reduce the cost of inventory. Predictive modeling should enable us to better estimate the number and types of sites that are likely to occur, make inventory effort more closely reflect resource expectations, and check the validity of survey results. In many instances, cost will be reduced because inventory efforts are focused on areas with higher potential for resource occurrence and correspondingly reduced for areas with low potential. Additionally, project planning activities (e.g., estimating field time and costs) should be enhanced by these efforts. Finally, a major benefit for archaeology will be to increase the value of our inventory results. When the effort we typically expend in one year can be put into a regional research framework, we are bound to learn more about the resource and its distribution across the varied landscapes of the Pacific Northwest.

ISSUES IN

ARCHAEOLOGICAL INVENTORY

AND

LOCATIONAL SITE MODELING

PREDICTIVE MODELING IN THE FOREST SERVICE

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Introduction

From January 26 to March 12, 1976, a program review of cultural resource management was conducted by a Forest Service task force under the direction of Deputy Chief Tom Nelson. The program review was in response to a concern that:

> ...the program for Cultural Resource Management is so costly to apply as to be seriously depleting the Forest Service's capability to produce other commodity and amenity values of the National Forests (Koskelly 1976).

Although the team could find no data to either substantiate or refute these concerns, the steady growth in the program since that time has done nothing to alleviate them. In spite of repeated concerns about the program, no action was taken to accumulate data with which to substantiate the size, cost and results of the program. This delay in the implementation of steps that could substantiate or refute charges of excessive cost was due to the relatively insignificant size of the total program, and the absence of an accounting system that could identify the amount of the total Forest Service budget going to CRM activities.

Another concern expressed in this report has had more serious implications for the existing CRM program and leads us directly to one of the major issues of this workshop. This has to do with the statutory direction that existed, or was believed to exist, in implementing the CRM program.

> It is generally conceded that, although desirable, EO 11593 instructions to Federal agencies to locate, inventory and nominate to the Federal Register [sic] all cultural resources under its jurisdiction that appear to qualify for listing appears to be a practical impossibility both because of the magnitude of the task and the staggering sums necessary for its completion (Koskelly 1976).

In an effort to meet compliance regulations within budgetary constraints, a CRM management strategy has developed that is best described as "locate and avoid." For the past decade or more this strategy has been applied to timber sales in the Northwest, range revegetation projects in the Great Basin, road construction in the Southeast, oil and gas exploration in the Northern Plains, and mining in the Northeast. A great backlog of identified but unevaluated cultural properties has accumulated, over 80,000 nationwide. In addition, some projects examined for sites have produced none. Managers complain about spending money to look in areas where no sites were found. They ask the question, "after years of survey, can't you archaeologists [sic] determine where sites are likely to be?" In turn, archaeologists complain about being required to look in project areas with little potential while being unable to examine non-project areas with high cultural resource potential. Data are recovered only from sites that are threatened with development, while sites with scientifically vital information are bypassed because they are not a barrier to federal development actions.

So from where does the interest in predictive modeling come? Some comes from the Forest manager concerned with the cost of the program: up from $50,000 in 1971 to nearly $10,000,000 in 1985. Some comes from professionals in the agency concerned with the growing propensity to conduct surveys only to locate sites which can then be avoided. Some comes from individuals in the agency and in the public community concerned that after a decade of intensive survey our knowledge of the history and prehistory of the National Forest System lands shows little commensurate increase.

Concerns and Issues

"Predictive Modeling" is a combination of words bound to generate a wide variety of reactions dependent upon the individual interpreting the phrase. Current archaeological literature is full of statements pro and con and lengthy dissertations about the relative merits or demerits of its application. It is useful at the beginning of this discussion to clarify the position of the Forest Service with respect to this current debate.

Since the role of the Washington Office in the preparation of this workshop has been remote, undoubtedly there are those here who harbor feelings ranging from curiosity to suspicion about the purpose of this meeting. There is likely to be even more suspicion expressed by some who are not participants here. Given the tenor of feelings expressed last April at the Society for American Archae-

ology meetings over the proposed Bureau of Land Management contract for a volume on predictive modeling, it is apparent—given recent events—that federal efforts in this field are seen as "Darth Vadian" in design by some individuals and groups.

McKinley Mine

An example of this is the McKinley Mine issue in New Mexico. There, in an attempt to design a plan for the cultural resources of a portion of the coal mine, an approach involving sample surveying, predictive modeling, and evaluation of sites against defined research questions was proposed. Problems developed almost immediately with the acceptability of the proposed plan. Although the New Mexico State Historic Preservation Officer was opposed to the plan, a review by the full Advisory Council on Historic Preservation resulted in a favorable recommendation. Even though the legal process had been concluded, the proposed plan for sampling, designing a model and then determining the need or lack of need for additional survey could not be implemented. Problems in obtaining a permit for the archaeological work resulted in a compromise by which complete survey was to be done and the sampling based upon the predictive model would be simulated. A variety of perspectives on this controversy are presented in a series of papers assembled and edited by Joe Tainter (Tainter 1984).

OSM-PMOA

In the same publication, a discussion of a proposed Programmatic Memorandum of Understanding between the Office of Surface Mining and the Advisory Council continued the argument begun in the McKinley Mine case. Of particular importance here is the discussion of the Section 106 process becoming almost too restrictive (King 1984:84). King argues that the OSM-PMOA was developed to bring all applicable laws together in a single effort and to undertake a preservation planning process as the basis of the compliance work. He points to the criticism that dealing with specific sites being impacted by federal projects often produces redundant information while critical data relevant to an understanding of the prehistoric resources lies buried in sites just beyond the area of direct impact. The prevalence of "data recovery" actions in compliance with Section 106 requirements has generated criticism leading to a GAO investigation of alleged excesses. As King suggests, much of the blame for any such excesses, if in fact any did exist, was largely the fault of the system of historic compliance and not the avarice of the archaeologists.

Although a number of archaeologists have argued for regional planning for a number of years, it appears that the impetus given to federal archaeology from Section 106 compliance actions has been almost impossible to overcome or redirect. Survey is "necessary" to find sites, testing is "necessary" to evaluate sites, and data recovery is "necessary" to mitigate potential adverse impacts. The preservation process has developed almost too well in some agencies. They have learned to comply with the law, but many, if not most, agencies are interested in "minimal" legal compliance. They want to do just enough to be "in compliance."

The unfortunate thing about Section 106 compliance as it has evolved in the federal government is that it allows very little flexibility in how one complies with the regulations. Agencies which have developed procedures which have withstood legal challenges, or have modified them due to legal challenges, are reluctant to take a chance with a new approach which might not be legally defensible. Proposals to advance the RP3 process at the State and Federal level have been hampered by this perception. Why spend the time and money planning and researching the background of a region when you will still be required to examine every acre, locate every site, and mitigate any adverse impact on every site threatened? Hence, the circularity of the problem, the emphasis on project-by-project compliance lends little to regional perspectives and the absence of regional perspectives result in redundant data recovery, tunnel vision, and charges of excessive costs.

King points out some of the devices considered in an attempt to break the circularity of this problem:

1. Increasing the standard of eligibility—fewer sites qualify and trigger the compliance process.
2. Separating prehistoric sites from historic properties and applying stricter standards and controls.
3. Setting up a "universal" archaeologist to impose order on the chaos with authority over all federal Departments and Agencies.
4. Requiring Section 106 actions only on sites determined to be of "national" importance.
5. Establishing ceilings on the number of sites that could be placed on the National Register, the extent of excavation allowed, and the dollar cost of archaeological programs.

None of these suggestions has yet been implemented, but there have been several strong attempts to gain acceptance of one or more of them and at least partial implementation of number 3. The OSM/ACHP PMOA was supposed to work like the RP3 process and develop a "historic management plan" that would be based upon survey. The plan would outline the strategies for com-

pleting the identification of significant properties and set forth methods for dealing with them. The plan would also have to determine the level of effort to be invested in the treatment of historic properties. The advantage seen in this process is its explicit nature and the fact that it must be completed before the project can begin. King considers it to be an optimal approach to the cultural resources likely to be affected as strategies can be devised that address the entire range of cultural resources in the area, not just individual sites.

Responses to the proposed agreement have ranged widely, with strong opposition coming from other archaeologists, particularly in the Southwest. Five points of criticism are addressed by King:

1. The use of predictive modeling.
2. The role of the SHPO and the surface management agencies.
3. The cost of the process.
4. The complexity of the process.
5. The legality of the process.

The most sensitive issue in the entire debate over McKinley Mine and the OSM-PMOA revolves around the first on this list, the proposed application of "predictive modeling." It is not the concept of using predictive models that upsets the critics of this proposal; it is the amount of survey that results from the application of a predictive model in a particular project. Some feel that total and intensive survey of any area that may be impacted is the only acceptable approach. King argues that not only do intensive surveys fail to find all sites, but that predictive models may increase the likelihood of locating certain kinds of sites (King 1984:87).

It would appear from the discussions of this issue that it is not "predictive modeling" that is the difficulty, but rather it is the amount of surveying that is carried out or not carried out based upon some belief that sites are likely or unlikely to occur in some environmental zone. The concept presented in this series of articles (Tainter 1984) that "predictive models cannot find unique sites" is really a statement that "sampling cannot find unique sites." Sampling strategies are seldom designed to locate rare phenomena or aberrant sites. We sample to discover norms or "typical" sites. Testing of random sampling strategies on Milkranch Point (DeBloois 1975) demonstrated the reliability of determining site densities with low percentage samples. At the same time individual site characteristics could not be reliably predicted because of the tendency for sites of different types to be non-randomly distributed over space. Other sampling strategies could have been used that would have increased one's ability to estimate the parameters of the population, but rare and unique sites must be approached differently.

Predictive modeling is not sampling, however. It must be based upon unbiased observation of cultural phenomena. Modeling can be based upon sampling, and sampling strategies can be designed based upon predictive models. Models can be built from small or large (100%) samples and sampling can be used to test models previously developed.

BLM Modeling

In a recent article in *American Antiquity,* Michael Berry raises a number of serious criticisms of federal applications of archaeological survey and predictive modeling (Berry 1984). Most of the examples he cites refer to Bureau of Land Management efforts with which he is familiar. He argues that the purpose of the "seemingly endless series of survey projects" is not entirely clear. I must disagree. The purpose of archaeological survey by federal agencies is patently clear—to "identify sites that appear to qualify for listing in the National Register." Having so stated, however, does not exonerate all federal survey projects, probably not even a few federal survey projects. With astonishing single-mindedness, federal agencies have plunged ahead with small surveys, large surveys, medium-sized surveys, long surveys and short surveys. Thousands of sites have been located, and reams of site reports have been filled with an enormous amount of information. The statutory requirement to identify cultural resources has been followed admirably, if not willingly.

A decade or more of this process of cultural resource "management" has resulted in the creation of several critical problems. These problems differ by which side of the fence one is on: that of the land manager, or that of the archaeologist. The land manager has seen millions of dollars spent in locating thousands of cultural properties of all kinds and sees that the majority of the inventory task still lies in the future. The archaeologist sees, as Berry suggests, that "an enormous amount of information has been recorded that *might* be put to some good use eventually." Enter predictive modeling.

As one of the results of the surveying effort, many federal and contract archaeologists became acquainted with the resource base to the extent that a certain level of expectation about where sites would be found was developed (predictive models). Why were sites found in some places and not in others? Could we increase our understanding of prehistoric behavior by understanding how sites were distributed across the landscape? Could we reduce the cost of survey if we could predict where we would and would not find sites? Predictive modeling offered rewards to both the archaeologist and the man-

ager. To one it offers a framework for hanging the "enormous amount of information" about the resource, while to the other it offers reduced program costs. So far so good.

Berry selects illustrations from a number of BLM applications of probability sampling and predictive modeling to demonstrate serious technical problems. He wonders why such abuses of probability sampling occur in the same area where notable achievements in regional sampling have been demonstrated (Berry 1984:842). If one cannot rely on the results of probability sampling due to gross errors in application, then predictive models built from these data are equally unreliable. So much for the potential framework for organizing inventory data. The only accomplishment has been the reduction in the cost of the sample survey, or is that indeed the case? If the sample cannot be used for obtaining the necessary legal clearances for the project and additional survey is required, the cost of the probability sample will be extraneous. It would likely have been less expensive to have conducted a non-probability survey.

If probability samples being utilized are not in fact probability samples, but rather biased and unreliable exercises, what about the predictive models based upon the data derived from them? Berry sees such modeling as not just wasteful of time and money, but

> ...an outright threat to archaeological sites due to the potential use of such models as substitutes for clearance surveys (Berry 1984:845).

Here we have the focus of the current controversy over predictive modeling. It is not modeling and it is not sampling, it is the substitution of expectation for verification that makes archaeologists uncomfortable. Berry points to the OSM-PMOA as an indication of the intention of federal agencies to do precisely that and concludes that federal cultural resource management

> ...has shifted from the conservation and interpretation of archaeological remains to the facilitation of energy related exploration and development on federal lands (Berry 1984:851).

This perspective is bound to make those who hold it suspicious of efforts of federal agencies to explore "predictive modeling" or to develop models for one project or another. BLM's effort to contract for a study of sampling and modeling undoubtedly generated a considerable amount of suspicion and anxiety about ultimate motives. I am certain that the scheduling of this workshop contributed to individuals' concern about federal motives with regard to sampling and predictive modeling.

Previous Forest Service Efforts

The Forest Service's efforts to explore predictive modeling and sampling stems from work done by the Southwest Anthropological Research Group (SARG) beginning in 1970. Several of the members of SARG were then or are now working for the Forest Service. The focus of SARG's work was the development of models of settlement based upon project data from throughout the Southwestern U.S. Although the questions asked were simple, the answers were not. SARG's work made it clear that prehistoric sites were distributed differently across the landscape from one area to another and that their relationship to existing environmental variables was neither obvious nor simple. Data available for analysis were often unreliable due to uncontrolled bias in the strategies used to collect them. Controlling these biases through probabilistic samples and comparable methods of observation would be vital to the success of the research. Over the years, participants gained a great deal of experience with survey design, data collection and model building.

Many of these lessons have been applied to the Forest Service's cultural resource management program. From this experience, the Forest Service program in the Southwestern Region evolved to the point where one observer could state:

> One of the beneficial effects of Federal historic preservation law has been the widespread adoption of archaeological survey methods that are (at least comparatively) consistent, reliable, and rigorous. The goal of this survey method is to cover the ground surface so thoroughly that most cultural remains will be found, and so that there is no systematic bias regarding those not found (Tainter 1984:82).

This statement is far more optimistic about federal programs than is evident in Berry's article and may reflect a distinction in the philosophies of the Forest Service and some other federal agencies with regard to how sampling and modeling should be used. The aim of efforts taken to date in the Forest Service has not been one of developing a replacement for the field survey, but rather it has been directed at refining the survey techniques being applied.

A symposium on high-altitude prehistoric sites was held in Santa Fe under the auspices of the School of American Research (Winter 1983). The result of this series of discussions led to a subsequent work session where the concept of "allocation" of cultural resources was advanced (Green and Plog 1983). This dealt with methods of determining relative values of sites which all

legally met the test of "eligibility" for the National Register. It attempted to provide a mechanism for the land manager to determine appropriate actions that might be selected given the "kind" of site involved.

In approaching "allocation" strategies, it became clear that determining relative values of sites from a scientific standpoint was largely dependent upon an understanding of the role of each site in the prehistoric past. In order to extend our understanding of these events and processes, models of adaptation, past behavior, and environmental relationships became important. At the same time, we were aware that there were other needs that could be met with appropriate models.

> It is expected that appropriate predictive models will become an important tool in the management of cultural resources. As a planning tool, they should permit the projection of resource potential, scaling of inventory effort to meet expectations, estimating resource values, projecting project costs, and checking on the validity and reliability of surveys conducted (DeBloois et al. 1984:1).

The purpose of recent efforts by the Forest Service to develop models of prehistoric and historic resources has been to break away from the strictly "compliance orientation" that had begun to stifle innovation and hinder progress. The Forest Service has made a significant effort over the last decade to develop planning procedures and practices that will enable the agency to manage timber resources, and other commodity resources. Cultural resources have not received similar attention by Forest Service planners. The requirements of "compliance" leave little time available to devote to the development of long-term strategies managing cultural resources. Data on cultural resource properties continue to accumulate with little attention being paid to the development of techniques that would enable us to contribute significantly to the planning process: "We have been attempting to keep one step ahead of the chainsaw and bulldozer with little time to look at where we are going or should be going" (DeBloois et al. 1984:1). A joint effort by the Washington Office and the Southwestern Region to explore the planning potential of predictive modeling resulted in a draft proposal (DeBloois et al. 1984) and in the first of what was planned to be a series of working sessions. This session, held in Taos, New Mexico, in May of 1983, had three main objectives:

> 1) [to] address a topic of importance to the management of cultural resources and to current archaeological thought, and 2) make a contribution to archaeological scholarship, and 3) publish the results in a timely manner (Cordell and Green 1984:2).

The first and third objectives were met; only time will tell if the the second objective of the session was met.

For several days, archaeologists from the Forest Service and the academic community met to examine, analyze and discuss data from a number of survey projects throughout the Southwest. Attention was focused upon "complete" surveys, not samples, in a preliminary effort to determine the potential for building predictive models. The question asked of each project was: would it have been possible, given these data, to design a survey strategy that would have resulted in the location of most of the sites by examining only part of the area? Where the answer was yes, one looked for environmental characteristics that could be used to define areas containing sites. The approach was simple and unsophisticated, as some critics have point out, but time constraints prohibited little else. The benefits of the session were considerable, however, in the number of possibilities and problems identified for future attention, in the amount of knowledge gained about the patterns of distribution of resources as they relate to current environmental conditions, and in the interaction that occurred between agency and academic archaeologists.

Why Mess Around with Predictive Models?

In the discussion of predictive modeling and inventory methods that follows this presentation, it will be useful to keep in mind some important premises.

> Predictive modeling in archaeology is a method for estimating the likelihood of the occurrence of cultural resource sites on the landscape for which the model was developed. It is not, as some suppose, a technique to predict precisely where sites are located in the absence of any empirical field data. Point prediction of that magnitude is not possible currently, nor can it be developed in the very near future. Surveys are still needed to actually locate sites, but models can be designed to give managers a sound basis for deciding where their limited survey dollars should be spent (Cordell and Green 1984:2).

We are interested in predictive models for the potential they hold with respect to the management of cultural resources on a long term basis. Modeling promises to allow planning on a regional basis that can be integrated into Forest Plans and managment strategies. Models may permit greater fiscal responsiveness to cultural resource needs than currently exists. Most importantly, modeling may provide us with the means for breaking out of the "compliance syndrome" and move on to more meaningful management of cultural resources. Budgetary and person-

nel limitations will never allow more than a minimal "compliance" program unless it can be demonstrated that some other approach can provide benefits worthy of the investment. Perhaps predictive modeling is not the answer. Perhaps its costs are out of proportion to the potential benefits. Perhaps our expectations cannot be met due to the complexities of the problems and the inability of our science to provide appropriate solutions.

Whose Idea is it Anyway?

The motivation behind predictive modeling proposals by federal agencies is believed by some to come from top level management; individuals whose interests in cultural resources are minimal and whose goals are anti-preservation (Berry 1984). No such motivation exists for those efforts in which I have been involved. If top management were, in fact, anxious to produce pseudo-predictive models as an excuse to avoid costly survey, it would be much easier to obtain funding for such development efforts than it is. Support for the program proposed in 1983 has never progressed beyond verbal agreement that the proposal has potential benefits. Were it not for the interest of some individual Forest Service archaeologists, predictive modeling would seldom be mentioned.

This is not to say that managers are not concerned with the high cost of survey. They most certainly are. They are also aware of the legal requirements of historic preservation. They also will occasionally ask why we seem reluctant or unable to make statements about the distribution of cultural resources on the landscape after all these years of survey. Forest Service managers are not novices when it comes to sampling theory and application; hence, they require little explanation about how it should be carried out and what its limitations are. They view sampling and modeling as logical approaches to the archaeological problems the agency faces, and they occasionally goad the archaeologist to take some action in this direction.

Predictive modeling and probability sampling strategies are being explored by cultural resource specialists for reasons that will benefit the cultural resource. There is no high level management conspiracy to develop a fancy-looking mathematical model that can be substituted for the survey of millions of acres of National Forest System land and thereby save the poor taxpayer millions, reduce the size of the National Debt, and avoid the complications of having to deal with hundreds of thousands of cultural properties.

What Effect Will Modeling Have on Survey?

Since it is not the primary objective of the predictive modeling effort now underway to achieve any reduction in the amount of survey required, the way surveys are currently performed will likely not be affected at all. That is assuming that surveys currently being conducted are appropriate, technically sound, and in conformance with existing standards and guidelines. In those cases where this is not true, the increased control required of surveys providing data for model development should improve survey techniques and increase the value of the data produced. The cost of some surveys may be increased due to more systematic methods being applied. Others might decrease in cost as extraneous data collection or inefficient methods are changed. Our goal is to produce better, less biased data meeting the requirements of model building and testing. Surveys will be more purposeful and the data produced will be utilized in the analysis and synthesis of regional processes and problems.

What Are We to Accomplish at This Session?

The objectives of this workshop are simple. We have invited a few people from the Forest Service and from different State and academic areas to participate in exploratory discussions about the issue of predictive modeling and sampling. At the end of the week we hope to produce a draft report capturing the ideas and suggestions of this group. We want to address the specific role of the Forest Service in cultural resource management and generate recommendations which the agency can adopt to improve the quality of work done and which will begin to address the growing backlog of accumulated information on cultural resources.

Can sampling and predictive modeling contribute to cultural resource and Forest planning efforts? What limitations exist with the application of these techniques? How do we combine the need for advance and predictive information prior to major projects with the requirements under preservation statutes? What steps should be taken by the Forest Service immediately and in the long term to improve the cultural resource management program? Can the use of sampling and predictive modeling help us be more cost efficient in achieving the goals of the program? These are but a few of the questions for which we seek answers at this workshop.

I regret that attendance at this session has to be limited, but experience has shown that for this kind of work group to be successful, the number of participants has to

be limited. It is intended that work done here will be available in print for others to review in the near future. This is a working conference and our success in meeting our goals will be directly dependent upon the amount of effort each person is willing to expend. As those who have read the report from the Southwestern Region's session can clearly see, we do not expect to solve all problems nor to develop a highly complex and sophisticated predictive model that can be applied to work in the Pacific Northwest. We hope only to explore the potential for applications of modeling and sampling in the Forest Service's CRM program and, perhaps, get the agency pointed in a direction that will lead to the resolution of some of our current problems and professional frustrations.

PREDICTIVE LOCATIONAL MODELS IN ARCHAEOLOGY: WHAT THEY ARE AND HOW THEY ARE BEING USED

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Abstract

This paper intends to take advantage of its early position in the session to suggest some definitions to guide discussion, and to propose a taxonomy of predictive locational models that focuses on the procedural logic (inductive vs. deductive), degree of operationalization, level of measurement, and target context as the most important dimensions of variability.

The main goal of this paper is to explore an issue most archaeologists would prefer to skirt: what are the legitimate uses of current predictive models? I think it is safe to assume that the interest of federal agencies in predictive models is not due *solely* to the potential of the hypothetico-deductive method in furthering our understanding of past human societies. If such modeling can save money, under what conditions is this possible? But this will bring us up against the question: What can we hope to learn from present survey practices in our National Forests? In what ways must we change present practice if we hope to learn more things, or other things? Let's start with some definitions.

What a Locational Model Is—and Isn't

A model can be many things: a physical representation of selected aspects of reality (as in the case of a map); a mathematical equation, or set of equations, predicting a value for some dependent variable on the basis of some values for some independent variables; or a set of rules showing how people represent their environment, and how they make decisions based on such representations, which is where an artificial intelligence-based model of human location and settlement would begin. Since any model can be used to make some sort of prediction, the phrase "predictive model" is redundant.

The models of interest here are simplified sets of testable hypotheses, based either on behavioral assumptions, or on empirical correlations, which at a minimum attempt to predict the loci of past human activities resulting in the deposition of artifacts or alteration of the landscape (Kohler n.d.). This definition seems innocuous, but it does contain some information. First, the fact that such models are simplifications of reality means that they are fallible; no model that is simple enough to be useful can possibly anticipate all the contingencies that might result in the deposition of cultural materials. Second, by virtue of making predictions, such models are, or should be, testable. Deciding what some concepts thrown about by archaeologists (such as intensification, differentiation, integration, even "locational preferences") actually entail is not a trivial operation, and a lot of space in our national journals is devoted to arguing such operationalization problems.

Finally, and most important, this definition asks us to think about both "past human activities"—the systemic context—and the resultant materials recovered in the archaeological context (Figure 1). But the process of translating from the dynamic living context to the static archaeological context requires that we understand (i.e., model and control for) not just the target groups' subsistence, settlement, and mobility organization, as is obvious, but also their technological organization and discard behavior; various depositional and post-depositional processes; how we see and define sites; how we record the individual artifacts, and groups of artifacts, found during survey; how we analyze these materials to discover patterning; and how we interpret that patterning (Ebert and Kohler n.d.). Every level coming between settlement systems, at the top of this figure, and interpretation, at the bottom, can be regarded as a group of potential "confounding" variables: something that, if it changes in some unsuspected or poorly understood manner, we would interpret as information about changing settlement patterns. For example, failure to find archaeological materials in dense lodgepole pine stands is interpretable as information about where people located their activities in prehistory only if we are confident that lack of discovery is *not* due to the fact that—

- no durable materials would be discarded in such an area, given the kinds of activities probably taking place;
- sediments or vegetational debris effectively burying cultural materials have accumulated;

- materials were previously removed by erosional processes or collected by someone else;
- only non-intensive survey with low sampling rates was undertaken;
- materials found in such areas were not recognized as cultural;
- isolated materials that were found were not analyzed for their locational properties, even though this was done for "sites";
- and so forth.

I am sure you could all add specific examples to this list (see also Collins 1975) but I think this adequately covers the major types of potential confounding variables.

In this figure there are two possible strategies for moving between the analytic context of the archaeologist trying to make sense of the archaeological record, and the systemic context in which that record originates. The top-down strategy is deductive: starting from general propositions about *how* people make decisions, the *goals* of that decision-making, and a detailed reconstruction of *paleoenvironments,* it is possible to make predictions about what sorts of activities might be conducted in what places, leaving behind what kinds of materials. The best-known example of such a strategy is probably that of David H. Thomas and his colleagues in the Great Basin (Williams et al. 1973), although in that case, expectations developed from Steward's ethnographies were substituted for first principles of human behavior.

The second strategy begins with our perception of the archaeological record, and attempts to make generalizations from those data about settlement systems in a larger region. It is important to note that this strategy does not really begin with the archaeological record, as is sometimes stated, but with *what we believe to be* the archaeological record. The differences between the "real" archaeological record, and what we believe it to be, lie principally in limited discoverability (especially in forests!) or poor sample design, but may also reflect biases due to flawed analysis or pattern-recognition techniques.

To illustrate how these latter biases may come into play, let's briefly examine two cultural resource inventory plans recently published for Region 6 Forests (Davis 1983:15-20; Marvin 1983:52-56) that attempt to correlate natural features (for example, landforms) with known historic and prehistoric cultural resources. Leaving aside the problems of sampling and discovery bias, which are generally recognized though perhaps underestimated, both plans tabulated the number of such resources that occur on landforms of different types. So far so good. But then each plan took the higher occurrence of sites on one landform type as a suggestion that sites were associated with that landform type. However, the relative *area* encompassed by each landform in the study area is not considered. Obviously if 50% of some population of sites occurs on a landform that constitutes 5% of the spatial population of interest, then (ignoring the problem of proxy variables) there is a strong positive association of sites with that specific landform. But if the same 50% of the sites instead occurs on a landform occupying 50% of the spatial population (or perhaps 75% of the population) there is no association, or even a negative association, between sites and that landform. This failure to construct a random model as a benchmark for comparison may be trivial or may be seriously biasing the authors' conclusions; there is no way to know from the reports.

Taken together, the distinction between the inductive generalization approach and the deductive implication approach, and Schiffer's (1972) distinction between the archaeological and the systemic contexts, suggest a taxonomy for locational models (Figure 2). In theory, an inductive model, even though it begins in the analytic context, could "target" the systemic context; that is, it could make predictions about how people were organized and where they located their activities in the past, based on the remains they left behind. Such an approach, of course, would require controlling for all the intervening variables identified in Figure 1. In normal practice, inductive models have targeted the archaeological context, or more accurately, the analytic context, since they attempt to predict only where we will find materials, using present survey techniques, and how we will interpret them, using present analysis techniques.

Deductive models, by contrast, *start* in the systemic context with statements about human behavior. Their task is somewhat different—they must make predictions about where materials will be found, and how they should be interpreted, based on expectations about human behavior. It would be easy to claim that deductive models are superior because they deal in behavior, but that is only part of the story. Deductive models are not useful unless they derive testable implications about the archaeological (really, analytic) context, and to do so, they too must also control for all those variables that intervene between systemic behavior and interpreted materials. *For either deductive or inductive models, explanation means successfully bridging the gap between the systemic and the analytic contexts.* This has not been attempted by most locational models: most deductive models remain stalled in the systemic context; most inductive models remain stalled in the analytic context.

Despite the fact that both inductive and deductive models have to overcome the same sorts of obstacles in translating behavior into interpreted cultural materials, or vice versa, I think there are at least three senses in which deductive models are preferable. First, if they are success-

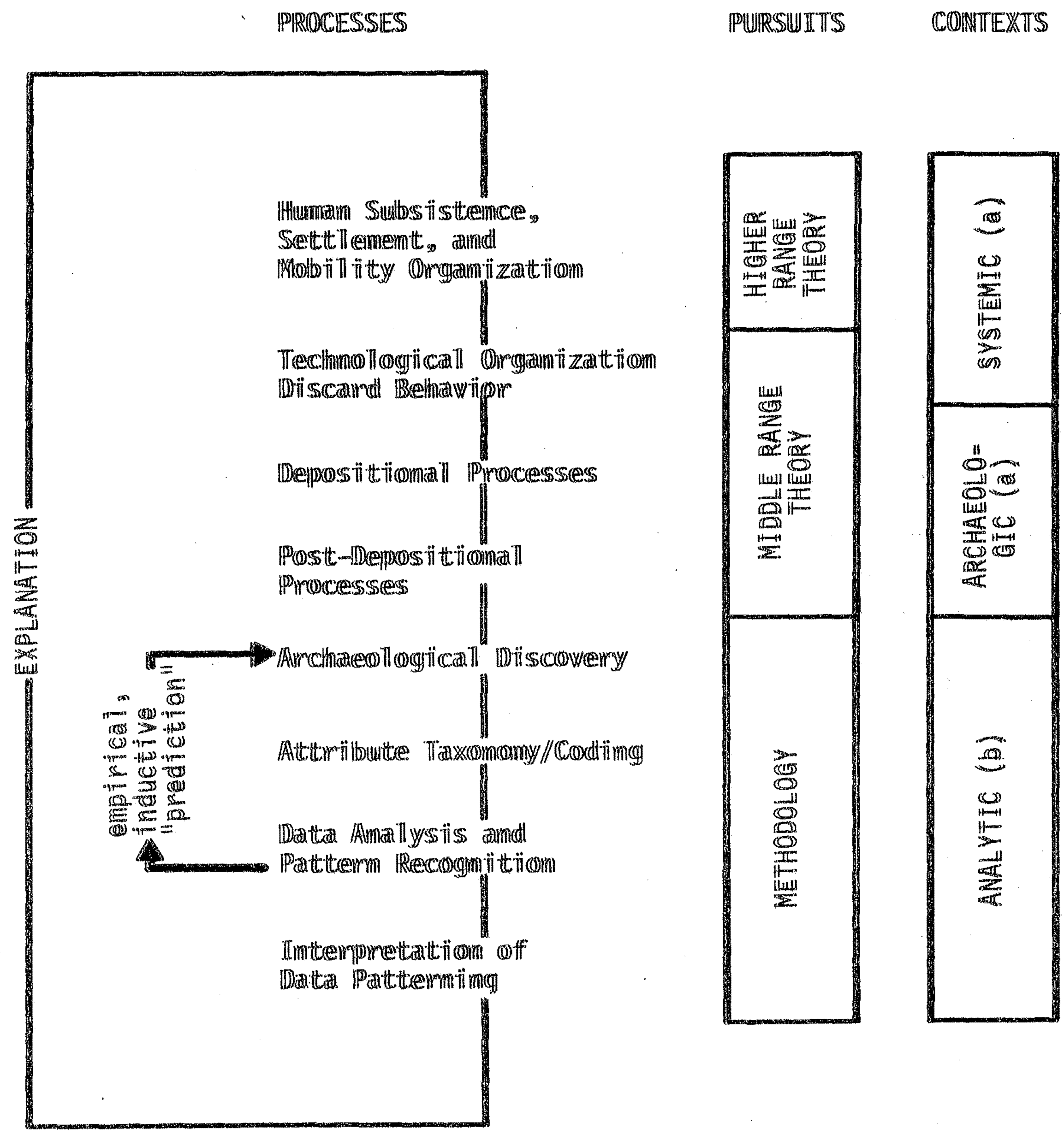

Figure 1: The explanatory framework for archaeological science. (a) as defined by Schiffer (1972). (b) as defined by Kohler et al. (n.d.). Adapted from Ebert and Kohler (n.d.).

Level of Measurement

NONE

TARGET CONTEXT	PROCEDURAL LOGIC: Inductive	PROCEDURAL LOGIC: Deductive
Systemic	1	Informal models based on logic or theory
Analytic	2	

NOMINAL/ORDINAL

TARGET CONTEXT	PROCEDURAL LOGIC: Inductive	PROCEDURAL LOGIC: Deductive
Systemic		4
Analytic	3	

INTERVAL/RATIO

TARGET CONTEXT	PROCEDURAL LOGIC: Inductive	PROCEDURAL LOGIC: Deductive
Systemic		6
Analytic	5	

EXAMPLES:

1. Many unquantified discussions of prehistoric settlement systems in particular regions; also, Binford's forage/collector model (1980).
2. Many unquantified discussions of prehistoric settlement patterns in Class I overviews (e.g., Franzen 1981: 95-100); see Stewart (1980:95-122) for a middle Atlantic example.
3. For example, Pilgram (1982).
4. For example, Limp and Carr (1985).
5. Most CRM predictive locational models, for example, Kvamme (1980); Nance et al. (1983).
6. Optimal foraging theory-based models (e.g., Winterhalder 1983:207-208) and other behaviorally-based approaches (e.g., Jochim 1976).

Figure 2: A taxonomy for predictive locational models in archaeology. Adapted from Kohler (n.d.).

ful in bridging that gap between materials and behavior, inductive models (since they begin with materials) end up making predictions about behavior in the systemic context. Unfortunately, unless we are operating as ethnologists or ethnoarchaeologists, such predictions cannot be immediately tested, since archaeologists do not observe the systemic context. Deductive models, if *they* are successful in bridging this same gap, end up making predictions about the analytic context, which is right where they can be tested. Explanatory *deductive* models are testable; explanatory *inductive* models are not.

Second, inductive models begin with a data base which is almost always flawed. Typically we don't know how bad these flaws are, but in forested environments the safest assumption to make is that the data are probably very flawed. Inductive models take all the discovery and analytic biases present in the sample and project them onto the spatial population, using statistical techniques such as discriminant analysis, or logistic regression. Although we strike out into the unknown when we formulate deductive models about how people actually behaved in various prehistoric contexts, my own view is that we are less likely to be seriously wrong in making assumptions about how people operate, than in trusting a data base accumulated with highly variable techniques, and probably containing multiple biases.

Third, deductive models *force* us to consider the systemic, behavioral context. But as archaeologists we are also *forced* to use the analytic context to test our predictions. This makes it more likely that the whole process of understanding and explanation (from the top to the bottom of Figure 1, or vice versa) will be carried out when a deductive logic is employed. On the other hand, the temptation when operating in an inductive mode is to start with observations in the analytic context, and make predictions about future observations in the analytic context. We never escape this narrow cycle, and never consider *why* any associations discovered work for prediction. Models for site location developed in this way have little chance of being applicable to other areas, or to other adaptation types. Cultural resource managers work in a legal framework requiring them to consider the information about human behavior and development that impute value to cultural resources. For this reason, if for no other, the systemic context must be considered.

One point that I hope is made in Figure 1 is that locational modeling cannot be compartmentalized from the entire research cycle. Of course, no archaeological research is purely inductive, or purely deductive. Primarily deductive approaches must draw on past data collection and generalization; intelligent generalization profits from the experience of any previous deductive model building and testing. Although it is useful to classify locational predictions as primarily inductive or primarily deductive in their approach, successful locational prediction, like other research, must draw on elements of both procedures.

How Locational Models Are Being Used in CRM

Nearly all locational models now available are primarily inductive, and target the analytic context. Paul Nickens (1984) recently interviewed district archaeologists in four BLM offices to find out how several such models developed for the northern Colorado Plateau were actually being used. He found that—

1. Areas designated "low probability" are frequently given "administrative clearances" based on model predictions, with no field inspection, in three of four BLM districts surveyed.
2. There is no universally followed policy regarding how, or whether, such clearances should in fact be made, and different districts utilize differing criteria in granting these clearances.
3. The models were also commonly consulted for information needed to prepare environmental assessments and statements, and in formulating cultural resource managament plans (Nickens 1984:7).

The Forest Service in the Southwestern Region is pursuing a two-track approach, attempting to develop both inductive and deductive models, which Green (1984:3) calls model building, and theory building, respectively. The inductive approach concentrates on designing survey strategies, after-the-fact, that could have been utilized in various Forests to avoid surveying areas that in fact had proved to have few or no cultural resources. Once again the emphasis—at least in this part of the process—was on defining areas where no survey would have resulted in no missed cultural resources. If such areas could be consistently and reliably defined, they would presumably be subject to administrative clearance without survey.

In at least two Pacific Northwest Forests, rather informal locational models based on a small amount of data, are being used to determine sampling proportion (but not intensity) in future survey. Areas similar to those where few resources were located in past surveys are sampled at very low rates, with survey effort concentrated in areas similar to those which, in the past, evidenced high densities of cultural resources.

In general, there appear to be several areas in which locational models are getting considerable use, despite their present early stage of development. Probably the

most economically compelling of these is to allow administrative clearances of low probability areas without further survey. A second is to stratify impact areas (such as timber sales) to concentrate survey effort in those areas most likely to yield cultural resources. Evan DeBloois et al. (1984:1) succinctly summarized these and other uses:

> As a planning tool, predictive models should permit the projection of resource potential, scaling of inventory effort to meet expectations, estimating resource values, projecting project costs, and checking on the validity and reliability of surveys conducted...Models will allow managers to project expectations onto project area maps or display expectations graphically. Job costing, time estimations, and other project planning activities will be facilitated. Survey efforts can be concentrated in areas of highest expectations and reduced in areas of low expectation. Sampling strategies demonstrated by predictive modeling to be most effective and efficient could be designed to maximize the amount of information collected for the amount expended.

Suggested Directions for Model Use and Development

Through all these examples runs the implicit or explicit suggestion that locational models can be used to determine survey proportion in impacted areas, or to provide administrative clearances in areas with low probability of containing archaeological resources. These two uses are equivalent except that in the first case, at least as presently practiced by the Forest Service, there is a commitment for eventual field inventory in areas presently only sampled at low proportions prior to disturbance.

At this point it is important to separate two questions: What is it legitimate to do with the kinds of predictive models that are being made, right now, for Pacific Northwest forests? But also, what might it be legitimate to do with a locational model that has been rigorously validated? Our answers to these two questions should be very different. Models that are currently being used to guide survey effort contain an unknown degree of bias due to poor visibility of the archaeological record in our Pacific Northwest forests; they discriminate against sparse (but perhaps not nonsignificant) distributions of materials that do not readily correspond to established ideas of sites; they do not take into account the changing prehistoric distributions of resources that help determine the location of human activities; and they remain more or less untested. I have a few suggestions for a short-term research program that addresses the issues of visibility and testing, and uses locational models in a more positive fashion.

Visibility problems for archaeological resources in depositional environments and heavily vegetated areas result in negative biases in sample surveys consisting of surface walk-overs with no attempts to remove sediments or vegetation. When we find something, we know it's there; but when we don't find something, we can't be sure it's not there. When this sample distribution is projected onto a spatial population, we get negatively-biased predictions: we are probably more correct in predicting the presence of archaeological materials in certain locations, than in predicting their absence in other locations.

As we have seen, locational models are currently employed primarily to focus survey effort on areas with probable dense distributions of archaeological resources. This may be good for archaeology, in the limited sense that it builds up the site inventory relatively rapidly. But it is also a strategy that may miss important segments of adaptations from some periods, while missing other periods entirely. Moreover, this approach may be neither cost-effective nor good management. Given that the available predictions of current inductive models based on previous surface survey are more likely correct for high density areas than for moderate or low density areas, why not avoid spending lots of money to fulfill self-fulfilling prophecies of finding dense archaeological resources in high probability areas? Let's instead use these predictions to argue against including such areas within timber sales, or other land-disturbing activities. (From a multiple-use perspective, such areas will often be those it is ideal to preserve for other reasons as well.) Let's trust the *positive* predictions of current models, and leave high site probability areas alone for awhile; let's inject this information into the early planning process for determining where timber sales and similar activities ought to be located in the first place.

On the other hand, let's be *very* wary of believing the predictions of current models for areas that are supposed to have moderate or low densities of archaeological materials. They may differ from high probability areas only in having very poor conditions of visibility. Or alternatively, they may provide evidence for a different but nonetheless interesting land use pattern. Recent experience in the devegetated draw-down zone of Libby Reservoir, in the Middle Kootenai River Valley of Northwest Montana, shows how crucial visibility is to estimates of site numbers in forest environments, and how sites may occur in areas where they might not have been expected (Thoms et al. 1984).

These considerations suggest some strategies for model building and verification. The only prediction about site location that archaeologists walking over 4" of litter can verify is the prediction of site absence, because whether or not there's anything there, it won't be discovered. I sug-

gest spending some of the money that is saved by avoiding survey in high-probability areas to step up in-progress monitoring of land-disturbing activities, and to permit intensive survey of cleared areas immediately after they have experienced superficial disturbance. Such a strategy, pursued conscientiously for perhaps several years, will permit the accumulation of *reliable* data on the occurrence of archaeological resources that can be used to build inductive models that both archaeologists and managers have some confidence in. At the same time, a program of deductive model building needs to be undertaken. The directions tentatively explored by the Southwestern Region in the first portions of the volume edited by Cordell and Green (1984) are exemplary in this regard. Finally, from a practical perspective, the accumulation and manipulation of the large amounts of spatial data needed to effectively build predictive models either beginning with the archaeological data, or beginning with human behavior and resource distributions, are too much for the old mylar overlay approach to deal with. Other papers in this volume discuss the use of geographic information systems to advance these purposes.

Conclusions

Present inductive models contain unknown but possibly large degrees of bias due to several factors, among which site discovery problems are probably the most severe. However, these existing models are likely to be reasonably accurate in their predictions of areas having high densities of archaeological resources. Planning should emphasize avoiding such areas. Reliable data on site location should be accumulated through more intensive project monitoring and increased survey of recently cleared areas, with preference for those areas that today are considered moderate or low priority for survey. While this groundwork is being laid, efforts to build "top-down," deductive models should be simultaneously developed. Beginning from opposite ends, both efforts work towards bridging the gap between prehistoric human behavior and the contemporary analytic context.

ACKNOWLEDGEMENTS

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SURVEY STRATEGY AND PREDICTIVE MODELING IN THE CONTEXT OF SITE DISCOVERY CONSTRAINTS

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Abstract

A preoccupation with sophisticated statistical techniques for analysis of survey data has tended to obscure the effects of site discovery constraints on the quality of the data. The imposition of idealized sampling procedures on the survey landscape is often necessary, but the choice of survey techniques and the interpretation of results must take into account the varying probability of site discovery. Furthermore, and as a corollary, survey data should be seen not simply as a means for associating sites with their locational parameters, but rather as a testing ground for proposed models of human behavior that have locational correlates.

Whether it be inspired by research aims or management directives, or a combination of the two, the basic goal of any archaeological survey is the discovery and description of the archaeological record as it is distributed across the landscape. I am concerned about the degree to which that goal is reached, and whether we might not know when it is not. In considering the issues that will inevitably be raised in this conference, I find myself wondering if our quest for better methodology, whether for survey strategy or for interpretation of the results, has not in some ways directed our attention away from a proper concern for the quality and significance of the data base. In the modern search for more sophisticated and "scientific" survey designs and analytical tools, is there enough effort made to understand those factors separating survey results from past human behavior and land use patterns? How much of the archaeological record do we actually observe during a survey, and to what extent do the patterns we find reflect human behavior and not site formation processes and site discovery constraints?

In reviewing the literature, I find, instead of such concerns, a generally abiding faith in survey results as direct reflections of prehistoric land use. Examples are easy to find. In his recent critique of current sampling methods and predictive modeling, Berry (1984) points out that contract archaeologists on western federal lands often overlook some of the basic principles of probability sampling, committing such errors as omitting confidence intervals. He further comments on some faulty specifications in BLM requests for proposals in Utah, including the sampling element definition and the arbitrary imposition of a specific sampling fraction. He pays special attention to the limitations of statistical techniques (particularly discriminant analysis) used in efforts at predictive modeling. I am in basic sympathy with all of these concerns, but I must point out that amongst this great attention to methods is the implied assumption that survey results, once the proper sampling methods have removed sample bias, within the limitations imposed by statistical variance, and provided satisfactory analytical techniques are chosen and used correctly, will map the distribution of archaeological sites as the exist on the ground.

This assumption is the foundation of an entire body of literature, yet it has not undergone much critical examination. The very useful summary of the predictive modeling literature by Kohler and Parker (n.d.) illustrates quite well that little creative thought or attention has been applied by recent model builders to problems of site discovery in survey areas. Kohler and Parker themselves do not ignore site discovery issues in their discussions, and in fact mention the necessity to consider the effects of vegetation and geomorphic processes (ibid:7,44) on sampling bias in the interpretations of survey results. The only mention of such considerations in the literature summary, however, involves two citations referencing geomorphic processes (ibid:21), and an interesting variable used in an Arkansas model, the Bermuda grass index (ibid:14), which perhaps not surprisingly was inversely related to site probability. In contrast to the short shrift given in the literature to site discovery problems, the Kohler and Parker summary, in its expansive review of recently applied statistical methods, demonstrates the energy now being directed at solving technical and analytical problems.

Unfortunately, while we in the archaeological profession are considering the complex issues involved in choosing among the alternative multivariate statistics of logistic regression, quadratic discriminant function, linear discriminant function, and multiple regression (ibid:23-33), we may tend to ignore the potential insufficiency of the survey data to reflect the actual distribution of cultural remains. For those conducting survey projects, whether or not they involve predictive modeling, it is perhaps understandable that the use of a standard probabilistic survey design may promote confidence that sampling bias has been removed and that one may now proceed to demonstrate one's erudition and proficiency in complex state-of-the-art statistical methodology. Such confidence may be without adequate justification.

Before continuing with this line of argument, I wish to disclaim any antipathy toward statistical methods, the Kohler and Parker paper, or predictive modeling. I am in fact a supporter of all three, despite my earlier comments that may seem to suggest otherwise. My cautionary approach here stems from an uneasiness about the uses to which predictive modeling, essentially a research tool, may be put for management purposes. Even those who assume that sampling bias can be practically removed by probabilistic survey designs have been able to point out serious weaknesses in the predictive capability of models (Berry 1984; Kohler and Parker n.d.:43-45; Tainter 1984; Dean 1984:20; Cordell, Dean and Tainter 1984:92). These weaknesses, supplemented by the additional weakness potentially created by residual sampling bias, must be considered in the adoption of predictive modeling as a management tool.

Limitations to Site Discovery

It is widely known, yet not often discussed, that survey results tend to constitute but a subset of the archaeological record that actually exists within the sampled survey area. Such a problem is implicitly recognized when specifications are adopted for the spacing or patterning of surveyor transects. These specifications control for the degree of survey intensity and improve the comparability of results from one survey tract or project to another. We know that some sites or objects will not be encountered, but assume that our methodology will render their proportion a constant.

Yet there are many other site discovery factors that are much more difficult to control. Some definitions may be useful here, including those for *site visibility, site erasure,* and *site exposure* (and *concealment).* Site visibility, as it has come to be used (Binford 1980; Dean 1984; Tainter 1984), refers to the degree to which the human use of a location produces a potentially lasting trace, and whether or not that trace is subsequently exposed on the surface. By this definition a winter village, for example, has high visibility even though it may be buried beneath five meters of sediment and impossible to locate by surface inspection, while a berry-picking location may have very low visibility despite excellent preservation and soil exposure. Site erasure is the degree to which a site with substantial visibility is removed from the archaeological record by events or processes subsequent to its creation. Such events or processes may include erosion by floods or wave action, as well as human activities such as strip mining, highway construction or pothunting. Site exposure, in the sense in which I shall use it, denotes the degree to which the visible traces of a site are capable of being noticed on the ground surface. Its opposite is site concealment. This is not strictly an attribute of the cultural deposit itself, but of the environment and conditions in which it is observed. In the examples noted above, the buried village site rates very low in exposure and the berry-picking site very high. Visibility, erasure and exposure are independent of each other, but operate together on the observer to produce what I shall call *site discoverability,* the degree to which the human use of a location has left traces that can be found by surface inspection. Thinking in these terms may serve to illustrate some of the limitations of the archaeological record as seen in survey data. Past human activities have varied widely in their visibility, many leaving essentially no traces whatsoever. For those sites with substantial visibility, erasure and exposure also vary widely, and consequently so will site discoverability. Of those sites with sufficient discoverability, only a fraction will actually be recorded during a survey, depending on the sampling fraction, survey intensity, and other factors.

Of the three main factors determining site discoverability, the least controllable appears to be site visibility, for which Tainter (1984:7) comments that "...at the present time our knowledge is probably insufficient to tackle the matter in much detail." Despite this problem, of course, we must keep in mind that models of land use and locational behavior should consider activities independently of their site visibility. At the level of survey design, however, site visibility may be uncontrollable.

Site erasure may produce sampling biases that may only be taken into account through a detailed understanding of the geomorphic background and the history of recent modifications of the survey area. We may not, of course, be able to know all of the causes and effects of site erasure in an area, particularly where geomorphic analyses have not been done thoroughly, and even where a detailed geomorphic and historic background exists we may never find out what sites have been lost to us forever. A good example of the latter case is the Oregon coast, where the waves of a rising sea have removed vast stretches of ocean frontage (Aikens 1984:69-70). An analogous case in the interior is Lake Abert (Pettigrew 1981a), where the waves of an expanded lake more than two millenia ago may have washed away entire sites on the eastern shore.

Anyone who has spent much time on field surveys should have some appreciation for site concealment. Although geomorphology is only one of several causes of site concealment, it has probably received the greatest degree of attention in this context. For example, it has been argued (Hammatt 1976) that Windust Phase sites on the lower Snake River are more common than apparent, having been buried by sediment. Floodplain sites on the lower Columbia River date to no earlier than about 3,000 BP, probably because earlier sites were buried as the floodplain accomodated to rising sea level (Pettigrew 1981b). Recent fieldwork at the Dietz Site, a fluted point site in southeastern Oregon (Willig 1984), suggests that Paleo-Indian sites are difficult to find in part because their traces may lie buried under shoreline deposits of vanished lakes. Examples of this kind are familiar and easy to find, and may indicate that geomorphic concealment is more widespread and important than even now recognized.

Less popular in the literature, but maybe even more problematic than geomorphic concealment, is concealment caused by vegetation. Vegetation may be the largest single cause of concealment in the Northwest, and the problem exists throughout the region, not simply in the jungles west of the Cascades. Recently, Connolly and Baxter (1983), focusing on western Oregon forests, have presented strong evidence indicating that vegetational concealment of sites can be so marked as to render probabilistic sampling nearly useless as a technique for examining site distributions. They point out that ground exposure is so limited, the vegetation so obstructive, and the terrain so rugged in these areas that site discovery is nearly impossible, and propose purposive and opportunistic, instead of probabilistic, sampling in the development of land-use models. In my own work involving highway surveys, vegetation is nearly always the greatest concealment problem. This is true especially on the west side of the Cascades, but to a great extent on the east side as well, even on arid basin floors. In a non-highway survey of nearly 11 square miles conducted last summer on the floor of the Lake Abert Basin (Oetting 1984; Pettigrew 1984), we noted the conspicuous absence of sites in harvested stubble fields immediately alongside unplanted areas of extremely high site density. In some cases lithic debris distributions terminated at the beginning of the harvested field. If vegetational concealment can introduce bias into survey samples even in arid basins, then it surely is a major problem on National Forest lands.

Beyond those factors that determine site discoverability are other constraints to site discoverability in the practical realm. I have already mentioned the spacing and patterning of survey transects and the fractional probability that a site will be encountered even within surveyed parcels. To this should be added the ruggedness of the terrain and the accessibility of survey quadrats, both of which make site discovery more difficult though far from impossible, and may bias survey samples if measures are not taken to compensate for them. The last such factor I shall mention, though there may be others, is the skill level of the surveyor. Though not often discussed, this factor may be a particular problem for large land managing agencies such as the Forest Service, that must cover vast acreages with a numerous, dispersed, and often temporary, staff. This problem, too, can be controlled, as the methodology employed for the Steens Mountain Prehistory Project suggests (Beck 1980). Where skill levels are not adequately controlled, however, an unmeasurable but possibly significant sampling bias may be introduced.

Implications and Conclusions

The foregoing discussion has been an effort to demonstrate that survey results should be treated with a substantial amount of healthy skepticism. Surely we can reduce sampling bias to its minimum by application of appropriate survey design methods, including such tools as probabilistic sampling, stratification, and so on, in situations where they offer advantages. We can control for skill levels, site encounter probabilities, accessibility, and perhaps other kinds of site discovery constraints. But we may *never* be able to remove the sampling bias introduced

by site discoverability. This is not a fatalistic attitude, but a practical one. I do not suggest that we should forego attempts to solve this problem in sampling, but I do suggest that we consider its implications.

The notion that survey data are not a map of past activity locations, but are rather an image of past locations as filtered and distorted by site discoverability, is not terribly revolutionary. This could be seen as an application of Schiffer's (1983) transformation view beyond the site level to the region. Understanding formation processes is a prerequisite to proper interpretation of survey data just as it is for exavation data. Site discoverability is really just the result of formation processes as they have influenced site distribution patterns.

Having found two different ways to say the same thing, though, still leaves us to consider the implications. First of all, it may be possible to control for site discoverability to an important extent, particularly with regard to its components site erasure and concealment. Detailed geomorphic study of a locality may offer information about the presence, absence and condition of natural deposits and surfaces of particular ages. The landform analyses and alluvial chronologies of Balster and Parsons (1968) in the Willamette Valley and Hammatt (1976) on the lower Snake River are two well-known cases where such work has been archaeologically useful. With regard to concealment caused by vegetation, the problem is possibly more difficult to handle. Not only is vegetation highly variable across the landscape, but it also has a habit of changing from time to time. It seems probable, though, that detailed mapping of vegetational concealment can be accomplished reasonably well, and that survey data can include this parameter. Such an effort would be a beginning toward controlling for vegetational concealment. Comparing site discovery patterns with site concealment patterns would make a wonderful addition to current analytical methodology.

Such a goal is far from being realized at present, however. The unfortunate fact appears to be that site discoverability is being largely ignored by site survey designers and theorists alike, who tend to proceed as though sampling bias has been safely removed once the correct probabilistic methods have been applied. Given my own suspicion that site discovery bias cannot be so easily controlled, I must question the reliability of predictive models that do not take this problem into account.

If we cannot guarantee that the recoverable site distribution pattern is a close approximation to the original pattern of used sites, or use survey data to recreate that original pattern, then our predictive modeling capabilities are seriously handicapped. Predictive models, particularly those based on the association of sites with environmental parameters, will reflect site discoverability bias as much as land use patterns. These empiric correlative models have already been criticized by Dean (1984) and by Kohler and Parker (n.d.) because of such practical difficulties as varying habitats and relevant environmental variables over time and the intercorrelation among predictor variables. To this list of difficulties I would add site discoverability, which tends to weaken the behavioral significance of correlations between site location and environmental parameters. I am thus in agreement with the authors just mentioned that the theoretical heart of any predictive modeling scheme should be explanatory rather than simply predictive, and should attempt to connect observed or inferred or predicted land use patterns with universal principles of human behavior.

Rather than launch into the theoretical stratosphere, as one may be tempted to do at this point, I find it more useful to consider the practical consequences of this discussion for those responsible for inventorying federal lands. Surveys still must be done, and funding constraints are as real as ever. Our discussions will be less than useful if they don't contribute toward improving the efficiency and utility of the inventory effort, and to this end I have some thoughts.

My suggestion begins with the proposition that, ignoring the distinction between inductive and deductive reasoning, there are two possible kinds of predictive models: those that predict where sites are located and those that predict where sites will be found. There is a perhaps subtle but strong difference between an idealized site distribution pattern that fits with our best understanding of both prehistoric environmental conditions and human site location behavior, and a more easily operationalized pattern of potential site discovery areas. The idealized pattern ignores site discoverability, while the latter pattern depends on it. I hold as a basic principle that all of expected impact areas should be surveyed, but, if less than that amount can be accomplished with available funding and staff, those areas that receive only fractional coverage should be chosen not on the basis of theoretical behavioral models that predict where sites don't exist, but rather more on the basis of practical evidence of where sites can't be found. Predictive modeling of site distribu-

tions is inevitably a difficult task that should be a long-range goal for the profession in its effort to understand the evolution and operation of human societies. It is a methodology in its infancy, and may not develop fast enough to reliably improve inventory efficiency in the short term. But site discoverability is quite suited to geographic analyses for which federal land managing agencies are already well equipped.

This suggestion of mine that survey intensity be based on site discoverability models rather than land use models does not imply that predictive models based on land use hypotheses have no place in public land management. Far from it. Analysis of site distribution patterns on large tracts of public land may provide the best possible data bases for developing valid models of past human societies and their relationships to the landscape. Inventorying the archaeological record, making that information available for analysis, preserving the resource base, generating models of human locational behavior, and mapping identifiable factors influencing site discoverability are important archaeological land management tasks. Assuring the availability and quality of sites and survey data will provide both the time and the data resources needed to test proposed models of human behavior that have locational correlates. In the long run, this data base will be of more use to archaeology than any number of site prediction models that can be produced at our current level of understanding.

ARCHAEOLOGICAL SITE SURVEY IN COASTAL AND NEAR-COASTAL AREAS OF WESTERN WASHINGTON

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Abstract

Archaeological site survey in this region is particularly difficult as a wide range of both cultural and environmental conditions here favor neither the preservation nor recognition of archaeological materials. To date, survey projects have employed both a direct historical approach and simple geomorphically-oriented predictive models, but relatively few sites have been found. Further, while sites probably occur at all elevations between the upland meadows and the nearshore subtidal areas, most known sites are associated with the atypically open ground of meadows and modern beaches. Although enhanced predictive modeling may improve conceptualization of possible past cultural adaptations, the practical difficulties of working (i.e., walking, observing the ground, subsurface testing, etc.) in this rugged landscape will probably remain a significant problem for archaeological survey.

Introduction

This paper will address the problems and potentials of archaeological site survey on the Olympic Peninsula of Washington, although it will deal much more with problems than with potentials. It will consider only Native American archaeological sites. It will examine what has been done in an effort to locate them, and what I believe we have learned from our activities thus far. While I appreciate that predictive modeling is a major focus of interest for many participants of this conference, this paper will not make significant contributions to the development of models on the Olympic Peninsula. Rather, it will offer some thoughts regarding the place of modeling within the problems facing surveyors here. While I don't wish to rain on anybody's parade, rain is a very conspicuous characteristic of the Olympic Peninsula.

Environmental Background

It will be useful to briefly consider some of the more dominant environmental conditions which affect archaeological survey on the Olympic Peninsula. As the entire range of human occupation—at least 12,000 years—is of interest, both modern and paleoenvironments will be considered, although the latter are only poorly known. This discussion, however, will only address a few points; for a more complete account, the reader is referred to works by Jones (1936), Heusser (1974, 1977), Tabor (1975), and Downing (1983).

The Olympic Peninsula currently offers the full range of salt water beaches present anywhere on the Northwest Coast. The peninsula has both protected (low energy) and exposed (high energy) beaches. Further, the region has both depositional and erosional beaches in both high and low energy settings.

The late Pleistocene and Holocene history of sea level changes along the margins of the Olympic Peninsula is only poorly known. It is clear, however, that the world wide eustatic sea level curve is highly complicated by local isostatic and tectonic effects, and both emergent and submergent coastlines occur. As a result, we may note that some shell midden deposits on the peninsula's west coast are presently as much as 50 feet above the modern intertidal zone, while along its northeastern coast, other shell midden deposits are present wholly within the modern intertidal zone.

The vast majority of all near-coastal areas are currently covered by very dense vegetation. The coastal plain is mantled by a lowland forest. True rain forests occur only in western portions of the plain, but plant communities are extremely dense throughout the region. The rugged upland areas contain a wider diversity of Canadian and Hudsonian zone forests, but these too are dense. Above the Hudsonian zone, the peninsula has a relatively small Alpine zone characterized by meadow-parkland plant communities with only limited tree cover. In total then, we can see that there are very few areas in the region which naturally lack forest cover; on the low ground there are beaches, streamways and a few prairies, on high ground there are the alpine meadows.

In very broad terms, the post-glacial history of this vegetation can be described. While most of the peninsula was covered by ice during the Fraser Glacial peak, by ca. 12,000 BP much of the area was shrubby steppe. Pines

and alders began to appear somewhat later, but it is likely that much of the peninsula was relatively open parkland throughout most of the early and middle Holocene. Developed forest communities do not begin to appear until the late Holocene and thus the dense, closed forest we see today may be only 3,000 to 4,000 years old.

Finally, no discussion of environment on the Olympic Peninsula should ignore its climate, or at least the most dramatic aspect of its climate: precipitation. It precipitates a lot: snow at higher elevations, rain below. Most of the west side of the peninsula receives in excess of 80 inches a year; the rain forests get more than 120 inches, and some western alpine areas get more than 240 inches. Precipitation patterns are strongly seasonal with as much as 75% coming between mid-October and mid-April, and this seasonal pattern has a marked effect on the hydrology here. The region's rivers have winter discharge rates from eight to ten times greater than their summer rates and this can result in an annual vertical fluctuation on the order of 10 to 20 feet.

All of these environmental conditions have important effects on archaeological survey. The weather is frequently poor. Erosion rates along the coast and on streamways are high. In the forest, ground visibility is poor to absent, and visibility in any other direction is usually not much better. Finally, forest soils are strongly acidic and they do not favor the preservation of organic materials.

Cultural Background

A brief consideration of ethnographic and archaeological background also will be useful. As was the case with the environmental review, this discussion will only touch on those issues which are relevant to archaeological survey on the Olympic Peninsula. For a more complete account, the reader is referred to works by Wessen (1983) and Bergland (1983, 1984).

The ethnographic cultures of this region were all notable for a very high degree of maritime and riverine orientation. It appears that these peoples had only a limited presence in the coastal forests and uplands. Thus, it is likely that most of their settlements were situated in the erosion prone zones of beaches and streamways.

The material culture of the ethnographic peoples was heavily dominated by organic materials. They worked extensively in bone and plant fibers and made relatively little use of stone. In particular, chipped stone industries were virtually absent. Thus, their occupations left relatively little in the way of nonperishable remains.

Turning to archaeology on the Olympic Peninsula, first it should be noted that it is a relatively recent activity and not all that much has been done. Better than 75% of all the archaeological research done in this area has been conducted since 1970 and most of it has been quite limited in its areal focus. The excavation of sites has been confined almost exclusively to the coastal zone, and the only really extensive studies have been associated with two waterlogged sites situated near the northwestern corner of the peninsula.

Archaeological site surveys have been somewhat more wide ranging, but site discovery has been restricted to only a few settings. Most known sites in the region are associated with modern beaches. Despite the presence of ethnographic settlements on streamways, the survey of these areas has only rarely produced sites. Further, while fortuitous discoveries have demonstrated that sites are present in the forest, archaeological site survey programs have *consistently failed* to find them. This warrants restating: to date, *all* known forest sites were fortuitous discoveries (i.e., they were inadvertantly exposed in road cuts, domestic excavations, or other disturbed situations); professional archaeological survey projects operating in the forest have yet to find a site. In contrast, a single survey project confining its focus to alpine parklands succeeded in locating at least 15 sites.

This survey track record clearly indicates that archaeologists don't do very well in the woods. We find sites both above and below the forest, but not within it, even though we know that some are there.

Finally, although I do not wish to get into the prehistory represented by the known sites, one observation about them is worthwhile. While virtually all of the sites associated with modern beaches are late prehistoric shell middens, forest and alpine parkland sites are lithic scatters which probably represent mid- or early Holocene occupations.

Site Survey Research Design

I would now like to turn to a consideration of survey research design on the Olympic Peninsula and in doing so, I would like to distinguish between what I will call strategy and tactics in archaeological site survey. The development of a predictive model (and/or a particular problem orientation) for a particular study area represents the survey strategy. In contrast, survey tactics are the field procedures for actual application of the model on the ground; that is, tactics are what you do after you get out of the car.

To date, there have been at least 35 archaeological site surveys in this region, although many have been of very small scale. By way of strategy, I would argue that virtually all have employed some form of predictive model, although in most cases such models have been simplistic and informal. Modifying the language proposed by Kohler and Parker (1984), they might be considered to be intuitive empiric correlative models. They have sought to identify environmental (often geomorphic) features thought to favor the deposition and/or preservation of cultural materials. Most such models have been oriented toward ethnographic-like adaptation types, and indeed, most surveys have had a strong direct historical dimension, focusing on ethno-historically reported localities.

Virtually all studies have been judgmental rather than probabilistic in their approach and there has been almost no effort to develop detailed statistical assessments of site location. This has been so for a number of reasons, many of which are related to the limited nature of relevant data sets. The currently available site records from this area are probably too sparse and biased to support useful modeling. Most types of modern environmental data also are limited, although recent developments in remote sensing may improve this situation (Gill and Hart 1983). Relevant paleoenvironmental data are similarly limited. Further, the region's dense vegetation and rugged terrain make rigorous application of probabilistic sampling difficult. The modeling work of Croes and Hackenberger (1984) probably comes closest to being a quantified predictor of site occurrence, but their efforts have been restricted to the examination of materials from a limited area and their models have never been applied to the problem of locating new sites.

Most models actually employed for survey purposes have been relatively simple notions which direct the focus of examination towards or away from particular landforms. This focus on landforms has been a useful articulation point for ideas about prehistoric settlement and subsistence, and it has had the further benefit of being something tangible which surveyors could use for orientation in the field. The two most frequently cited landform characteristics are slope and proximity to water. Slope is easily the most dominant single determinant; surveyors have routinely eschewed slopes of greater than 30-40% and large portions of this region have been dismissed on this basis alone. Proximity to water is a characteristic which has been widely used, but which may have problems in a paleoenvironmental context. Proximity to preferred food resources is also often cited; and while this is not actually a landform characteristic, in practical terms it has considerable overlap with proximity to water. Still other landform characteristics which have occasionally been mentioned are proximity to low divides or natural passes and proximity to natural vista points.

Regardless of the form of their stated strategy, many surveys—particularly forest surveys—have failed to locate prehistoric sites. As the only real measure of the value of a site location model must be its capacity to accurately predict the locations of sites, it is perhaps tempting to suggest that models employed here have been inappropriate. However, I suggest that such a conclusion is misleading and that it does not recognize what I believe are the major survey problems of this region. While there can be no question but that local survey models are simplistic, the environmental constraints of survey fieldwork may often preclude adequate model testing. Thus, in a very real sense, model testing can be seen as a tactical concern, and I suggest that tactical difficulties—not limitations of model design—are the major factors responsible for the limited cultural data base presently available to us. It is not so much that we have been looking in the wrong places, but rather that what we are looking for is often very difficult to see!

Tactical difficulties for site survey on the Olympic Peninsula fall in either of two areas: problems of access or problems of investigation. Problems of access concern the ability of survey archaeologists to move and orient themselves in the landscape; to be able to get to localities suggested by a predictive model. Beyond roads and trails, the vegetation and terrain of this area frequently make back country travel difficult. In fact, many types of plants here can grow in communities so dense that unaided transit through them is virtually impossible. Problems of investigation concern how surveyors will detect the presence of cultural materials at any particular locality, once they have gotten there. As noted, ground visibility is typically poor to absent and many sites may contain relatively few nonperishable materials. Further, both frequently stony soils and a very high density of plant roots complicate most types of subsurface probing.

As we have already seen, in those settings where tactical difficulties are minimal, site discovery has not been a problem. On the relatively open ground of modern beaches and alpine parklands, simple pedestrian ground inspection tactics can be employed and site detection has been relatively straight forward. Typically, surveys in these areas have shown little interest in predictive models or such labor intensive field techniques as subsurface probing. Yet these surveys account for the vast majority of all known sites.

In contrast, tactical difficulties are greatest in the forest, and this is where site discovery has been the paramount problem. Here, researchers have made relatively more elaborate assessments of where sites should be (i.e., predictive models), and then proceeded into the forest to see what they could see. All such surveys have shown considerable interest in inspecting whatever naturally occur-

ring subsurface exposures were available, notably streambanks, animal burrows, and blown down trees. Many, though incredibly not all, such surveys have also employed some degree of subsurface probing. Typically, soil augers and simple shovel tests have been used. Nevertheless, these surveys have not found sites.

It must be said that, despite the special problems of survey in this region, there has been little effort to develop specialized tactics here. Site detection remains dependent upon visual confirmation of the presence of cultural materials and there have been only limited and generally unsuccessful efforts to locate sites through such indirect means as soil chemistry or vegetation studies. In 1978 I attempted to use soil phosphate and soil pH testing, but the results were disappointing and I don't believe that they have been tried since. Similarly, while a few researchers (Stallard and Denman 1955, and Wessen 1978) have speculated about the possible association of particular plants or seral communities with cultural deposits, the idea has never been developed. Finally, while surveyors have been aware of the special potential of waterlogged sites, no real efforts have been made to enhance the likelihood of their discovery.

Before leaving the subject of survey strategy and tactics, I would also like to briefly mention the most neglected portion of the Olympic Peninsula: the intertidal and subtidal areas. At present, a few fortuitously discovered intertidal cultural resources are known, but I don't believe that these areas have ever been the subject of formal survey consideration. Clearly, such survey poses major tactical problems. However, efforts at such survey are being developed in other regions (Masters and Flemming 1983) and they should be attempted here.

Recommendations and Conclusions

In view of this relatively bleak picture of archaeological survey on the Olympic Peninsula, it would be wonderful if I could conclude with some recommendations which would dramatically improve this situation. Unfortunately, I can't. Nonetheless, it is clear that both survey strategy and survey tactics have plenty of room for refinement.

Predictive modeling unquestionably has significant potential and there are at least two different kinds of models which can be of particular importance: models of early and middle Holocene adaptation types, and models of waterlogged site occurrence. The former will aid in the search of forest areas and the latter will aid in the search for truly well preserved sites. However, even really well developed and sophisticated models will not make site detection simple. Such models may provide better suggestions about where to look, but they won't make cultural materials easier to see.

The tactical difficulties of survey here are likely to remain for the foreseeable future. Despite their inauspicious beginnings, I believe that such indirect site detection techniques as soil chemistry and vegetation studies are potentially important and that they should be pursued. While I have no specific recommendations as to technique, I can suggest that the few known forest sites are the logical places to begin such studies. Detailed analysis of these localities should provide important insights valuable to subsequent surveys.

Finally, I will offer only one additional recommendation and that is: persistence. The Olympic Peninsula remains a rugged and wild place where most kinds of investigation are difficult. Compared to most other areas, archaeological site survey here will probably always be relatively labor-intensive. Nevertheless, real progress has been made in this region in recent years and I am confident that dogged persistence will produce still more.

ON THE CONCEPTS OF "SIGNIFICANCE" AND "SITE": IMPLICATIONS FOR INVENTORYING ARCHAEOLOGICAL RESOURCES

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Abstract

Inventorying archaeological resources and determining which of those resources are worthy of preservation are common aspects of modern archaeology. These aspects are implemented by using the concepts of "site" and "significance," respectively. As commonly used, the concept of "site" precludes consideration of isolated finds, a major constituent of the archaeological record. Use of the significance concept must be founded on a research design because the concept itself is ambiguous and tautological. The nature of research designs, however, insures some types of archaeological resources will not *be preserved. Consequently, assessments of "not significant" for sites and isolated finds must be well argued and strongly justified.*

Introduction

On May 13, 1971, President Richard Nixon signed Executive Order 11593. That piece of legislation ordered, in Section 2, part (a), federal agencies to "locate, inventory, and nominate to the Secretary of the Interior, all sites, buildings, districts, and objects under their jurisdiction or control that appear to qualify for listing on the National Register of Historic Places...no later than July 1, 1973." Needless to say, no agency has yet accomplished this task, despite the decade-long extension of the July 1973 deadline. There are several reasons for this, perhaps the most relevant one for our concerns being that there are many tens of thousands more "sites, buildings, districts, and objects" than any of us would have guessed 10 to 15 years ago. One reason our estimates of site abundances might have been so inaccurate a decade ago emanates from a changing epistemology of what constitutes the archaeological record.[1] As Robert Foley (1981:157), among others, has noted, "the archaeological record is not a fixed and immutable entity but a product of our perception."

In the 1960's, the operational definition of the record was "sites" (Table 1), or, horizontally extensive, well-stratified and vertically extensive dense concentrations of artifacts, ecofacts, and features. It is apparent in the literature that the basis for this definition emanates from the major archaeological paradigm of the 1960's—the culture history paradigm—which involves describing time-space variation in the archaeological record (cf. Binford 1968; Dunnell 1978), particularly the temporal aspect. The second basis for the definition emanates from a desire to be cost-efficient in data recovery. For example, in order to date an archaeological phenomenon by seriation, a large sample is necessary, preferably from a stratified context, and the quickest and least expensive way to acquire such a sample is to work at a large site (e.g., Michels (1973:81) states "sampling error caused by the smallness of the sample is often the most serious form of error" in seriation). I refer to this perspective of the archaeological record as the *Teotihuacan syndrome.* From this perspective, only the big, deep sites are valuable, or in today's terms, significant.[2]

About the time EO#11593 was signed, the epistemology of the concept of the archaeological record was changing. Binford's (1964) classic paper "A Consideration of Archaeological Research Design" was published in 1964 and was beginning to have an effect on how archaeology could and should be done if it was to realize a new goal subsumable under what usually is referred to as the "new archaeology." Today, the "new archaeology" consists of the cultural reconstruction paradigm and the culture process paradigm, as well as the culture history paradigm (Binford 1968; Dunnell 1978; Gibbon 1984). Archaeological research conducted under the auspices of these paradigms often is better accomplished at a regional rather than at a site-specific scale. Under the "new archaeology," David Hurst Thomas (1975) and his colleagues, among others (e.g., Dancey 1973, 1974, 1976), developed what can be seen as the opposite end of a continuum defined by the Teotihuacan Syndrome at one end, and what Thomas (1975:62) refers to as "Easter Egg Sampling" or *non-site* or *off-site* sampling at the other end (Figure 3).

I think that almost everyone would argue that many big, deep sites are significant. As well, many archaeologists would probably argue that *unique* sites are significant. For example, when initially discovered in 1977, the Manis Mastodon site (Gustafson et al. 1979; Gilbow

Table 1: Some Definitions of "Site" Derived From College-Level Archaeology Text Books.

AUTHOR	DATE	DEFINITION
Hole and Heizer	1965	A site is any place, large or small, where artifacts are found...A site may be as large as a city or as small as the spot where an arrowhead lies. (page 133)
Hole and Heizer	1969	A site is any place, large or small, where there are to be found traces of ancient occupation or activity. The usual clue to a site is the presence of artifacts...Some sites are as large as a city, others as small as the spot where an arrowhead lies. (page 59)
Hole and Heizer	1977	A site is any place, large or small, where there are found to be traces of ancient occupation or activity. The usual clue is the presence of artifacts. (page 86) (Note that this most recent definition excludes isolated finds while the two earlier ones included isolated finds by definition.)
Heizer	1958	An archaeological site survey is designed to provide information on the number, the location, and the nature of archaeological remains in a given region. (page 3)
Heizer and Graham	1967	An archaeological site is usually the scene of some past human activity. It might be defined by the slight remnants of a brief encampment, or by the abundant remains of a settled village. (page 14)
Hester, Heizer and Graham	1975	An archaeological site is usually the scene of past human activity. It may be marked by scanty remnants of a brief encampment, or by the abundant remains of a settled village. (page 13)
Fagan	1981	Any place where humanly manufactured or modified objects, features, or ecofacts are found. (page 553)
Rathje and Schiffer	1982	The place where material remains were left by human activities. (page 11) A place that has material remains of human activities. (page 396)
Rouse	1972	Any place in which archaeological remains have been found. (page 33) Any place in which an appreciable number of archaeological remains have been accumulated. (page 291)
Sharer and Ashmore	1979	A spatial clustering of archaeological data, comprising artifacts, ecofacts, and features in any combination. (page 568)

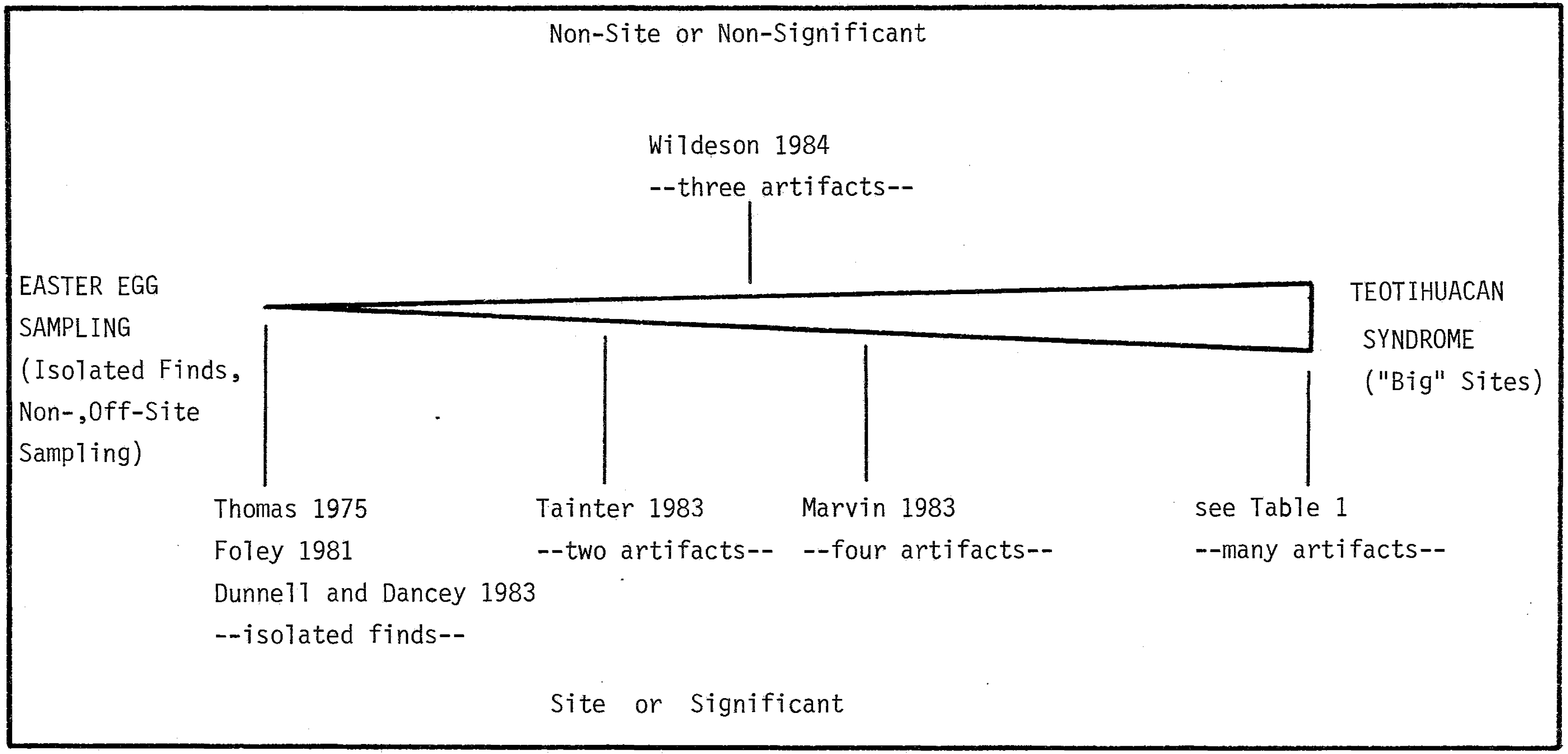

Figure 3: The continuum of artifact density in the archaeological record. References indicated are discussed in the text.

1981) was unique. It was, at that time, the only archaeological site in North America wherein evidence was found that humans were *clearly and unequivocally* associated with mastodon bones. In the seven years since the discovery of the Manis site, at least four other archaeological sites with clear evidence of humans associated with mastodon bones have been recorded (Fisher 1984a, 1984b; Graham et al. 1981; Shipman et al. 1984). Clearly, on a continent-wide scale, Manis no longer is unique; it is, however, still (for the moment) unique on a state-wide scale. Uniqueness may, therefore, be only a briefly applicable criterion of significance.

I have read final contract-fulfilling reports written in 1982-83 (e.g., Brauner and Lebow 1983; Minor and Toepel 1983) that refer solely to either or both the Teotihuacan Syndrome and/or the uniqueness criterion in the context of rendering significance decisions. Thus, it is not surprising that many of these decisions are couched in terms of the culture history paradigm. While we all know that we cannot save all archaeological resources, it is unclear why the belief persists today that only the big ones (Teotihuacans) and the unique ones are significant and thus should be saved, and why the culture history paradigm is generally (though not always) the basis for rendering significance decisions.

Given the above perception of archaeological resource management, an in-depth study of key concepts can begin. I think we must first consider the significance concept and our modern conception of the archaeological record, and then (by example) how we might operationalize these concepts in order to find our way out of what I perceive as major dilemmas in how the archaeological record is managed and how resource inventorying is accomplished today.

Significance

Are all big, deep sites significant? Are all small, disperse scatters of flakes significant? Is each and every isolated flake and projectile point significant? To answer these questions, we must first determine what we mean by "significant." As Tainter and Lucas (1983:709-710) recently pointed out, the federally mandated definition and criteria of "significance" are vague, tautological, and "allow almost any archaeological site to be justified as significant."[3] The source of the ambiguity is said to emanate from "the notion that significance is an intrinsic characteristic of cultural properties" (Tainter and Lucas 1983:710-711). After pointing out the weaknesses of the philosophical underpinnings of this notion, Tainter and Lucas (1983:714) note that "significance is a quality that we assign to a cultural resource based on the theoretical framework within which we happen to be thinking...and thus it can vary between individuals and change through time." I see this latter characteristic as valuable in the sense that a wide range of archaeological resources can be deemed significant; Tainter and Lucas tend to view it as a fault to the concept because of a lack of consistency in significance assessments. I think there is a degree of truth to both perceptions, and thus both must be considered. Ultimately, one of the most important suggestions that Tainter and Lucas (1983:716) make is that archaeologists should argue just as hard that a particular cultural resource is *not* significant as they do when arguing that another resource *is* significant. This is something that I have seen very little of in the literature with which I am familiar.

In another recent paper, Dunnell (1984) expresses concerns similar to those of Tainter and Lucas (1983), and adds that the significance concept has become a general one wherein cultural resources are evaluated relative to each other rather than against some set of particular absolute values (see, for example, Lynott 1980). Of course, as Tainter and Lucas (1983) imply, a set of absolute values might be found in the significance concept *if* (and this is a major IF) cultural resources were intrinsically valuable (see also Sharrock and Grayson 1979). Because cultural resources do not at present appear to have such an intrinsic value, and because objective criteria are not available, a "research design" usually provides the scale for weighing the relative values of particular cultural resources. But, as Dunnell (1984:69) points out, the research design chosen has at its base a particular problem orientation which in turn results in the sacrifice of some kinds of data in order to collect data relevant to the particular problem(s) embodied in the research design. This basis, then, generally contravenes the futuristic intent of all CRM legislation; that is, to salvage some kinds of data and sacrifice others does not serve the conservation-preservation ethic.[4] Dunnell's (1984:71) solution is to preserve a representative sample of geographically defined spatial units rather than archaeologically defined units like sites. This, he believes, will "insure the survival of a representative sample of the archaeological remains contained within the spatial units."

Dunnell's (1984) suggestion is similar to one made by Lipe (1974) a decade earlier. Lipe (1974:228) suggested

> preservation of a representative sample of this country's archaeological resources would at least theoretically permit any type of research to be carried out on the sample that could have been carried out on the original intact population. A sample selected on the basis of current ideas of significance would be biased, and might exclude some future research and educational possibilities.

While Lipe (1974:228) was arguing that we should preserve a sample "of all archaeological *sites* that exist," and thus his argument hinges on the perception of the archaeological record as a set of artifact clusters, his position that "the principle of representativeness is a better one to use in setting up archaeological preserves than is the principle of significance" appears correct.

I tend to agree with Sharrock and Grayson (1979) that the significance concept, as defined by federal legislation, is a useful concept. But as Raab and Klinger (1979) point out, decisions must be made *today* concerning which resources *are* and which *are not* protected in particular cases. I thus perceive two key hindrances to implementing the CRM legislation and to meeting the conservation-preservation intent of that legislation. On the one hand, we do not have a set of absolute values with which to evaluate every individual archaeological resource (be it a site or an isolated artifact) as required by real-world cases of CRM decision-making. On the other hand, we are faced with a sampling paradox. Because we do not know the total inventory of archaeological resources, we cannot produce a representative list of those resources that should be preserved. We therefore cannot know if our decisions today are truly reasonable in terms of what might be of interest to the researchers of tomorrow. As well, the premise of Dunnell and Lipe is unreasonable, as will become clear below.

Over the past decade, we have learned much about variabilty in human land use practices and the resultant distributions of potential archaeological resources (e.g., Bettinger 1980; Binford 1980, 1982, 1983; Kelly 1983; Kirch 1980). For example, we have learned that people, particularly mobile hunter-gatherer groups, tend to use much of the landscape on which they live and that they deposit artifacts over that landscape in different densities. Thus, archaeologists like Dunnell and Lipe have suggested that we preserve units of geographic space to insure that we preserve a representative sample of the complete archaeological record. Until recently, I agreed with this potential solution to the CRM dilemma. Now, however, as argued below, I believe even this solution may not accomplish what we hope it will. In order to evaluate this solution, we must first consider the constituents of the archaeological record and their structure (i.e., their distribution in space).

The Archaeological Record

I discussed above the fact that our perception of the archaeological record has changed in the last two decades, largely as a result of paradigm shifts in the discipline of archaeology. Foley (1981:163) presented sound theoretical arguments and supportive empirical data for the conclusion that "the archaeological record of mobile peoples should be viewed not as a system of structured sites, but as a pattern of continuous artifact distribution [varying in] density." Similarly, Dunnell and Dancey (1983:272) propose that "the archaeological record is most usefully conceived as a more or less continuous distribution of artifacts over the land surface with highly variable density characteristics."

Neither Dunnell and Dancey (1983) nor Foley (1981) are arguing that we abandon the *site* concept. For instance, Foley (1981:166) perceptively notes that "neither on-site nor off-site [archaeological] theory alone can account for the extent and nature of archaeological variability." On a more empirical level, Dunnell and Dancey (1983:271) point out that "setting site boundaries is an archaeological decision, not an observation" (see, for example, Chartkoff 1978).[5] This means the definitional criteria of site boundaries (and thus discernment of on-site and off-site areas) can vary from investigator to investigator and from site to site (Tainter 1983). Dunnell and Dancey (1983:273) argue that because of these factors, archaeologists should plot the spatial distribution of artifacts in a geographic spatial unit, and then define site boundaries on the basis of some empirically determined density value; "artifacts can then be assigned to either sites or between site space."

To be sure, the concept of *site* provides us with a useful bookkeeping device, just as the concept of *feature* does. I will not dispute the fact that sites are real empirical phenomena. I emphasize, however, that as empirical phenomena, sites must be defined with empirical criteria in order that they may be recognized. The definitive criteria should be theoretically founded (cf. Dunnell 1971). The point to be concerned with in the context of this discussion is that if we truly are interested in conserving archaeological resources, how can we do so when the site concept holds such a dictatorial role in conservation decisions and is such an awkward concept to use (cf. Tainter 1983)?

An Example

About a year and a half ago, I was near the conceptual point outlined above. At that time, I had the opportunity to design and implement an archaeological resources survey of the Redmond Military Training Area (hereafter RTA) in central Oregon (Lyman et al. 1983). The RTA is an irregularly shaped block of land totaling 25,000 acres, of which we were required to survey a 10% sample, or 2,500 acres (Figures 4, 5, and 6). Our goal, as dictated by the Bureau of Land Management (which administers the

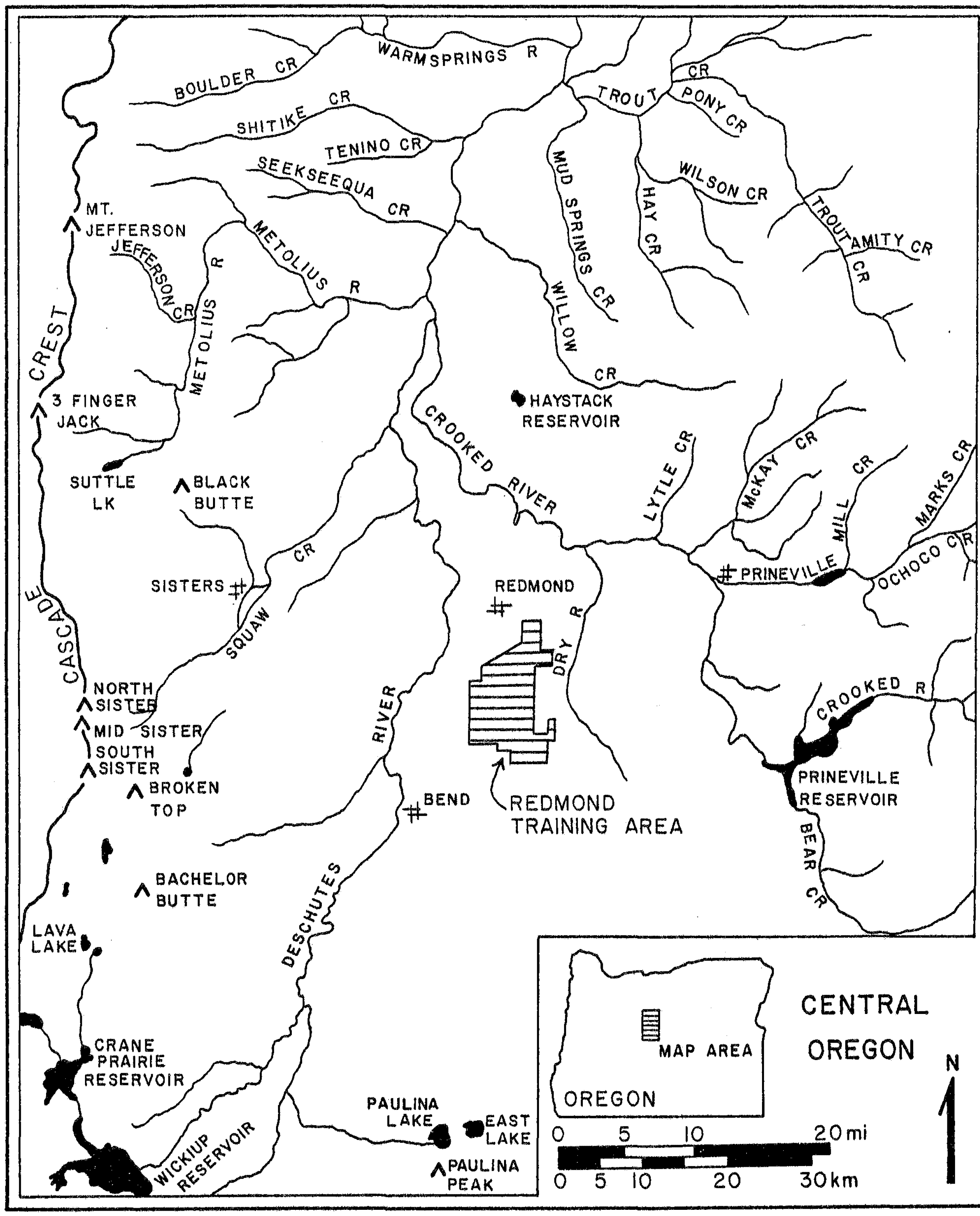

Figure 4: General location of the Redmond Training Area and geographic place names in central Oregon.

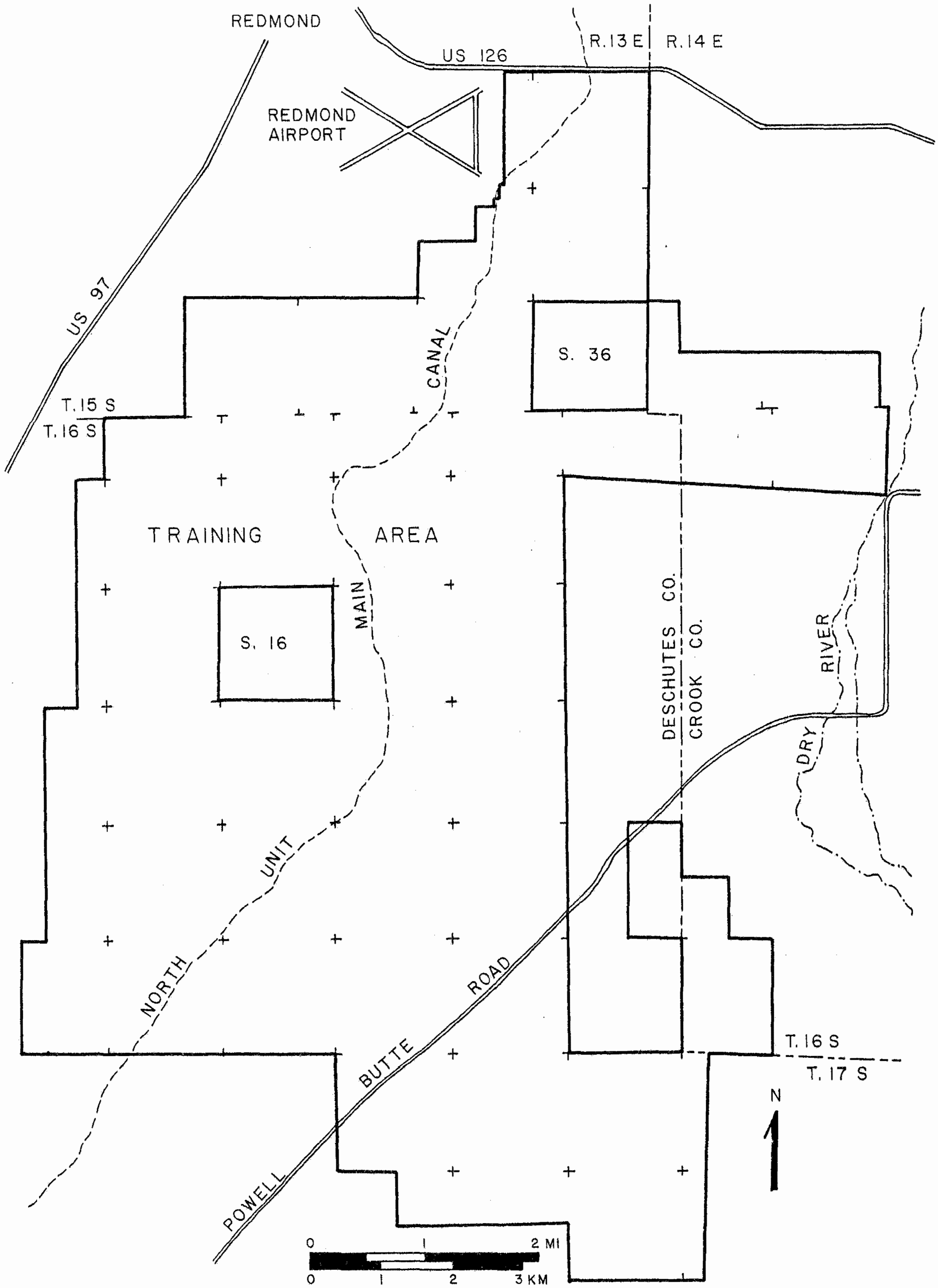

Figure 5: Detailed map of the Redmond Training Area. Grid ticks denote section corners. Note that Section 36 (T. 15 S, R. 13 E) and Section 16 (T. 16 S, R. 13 E) are not part of the Training Area.

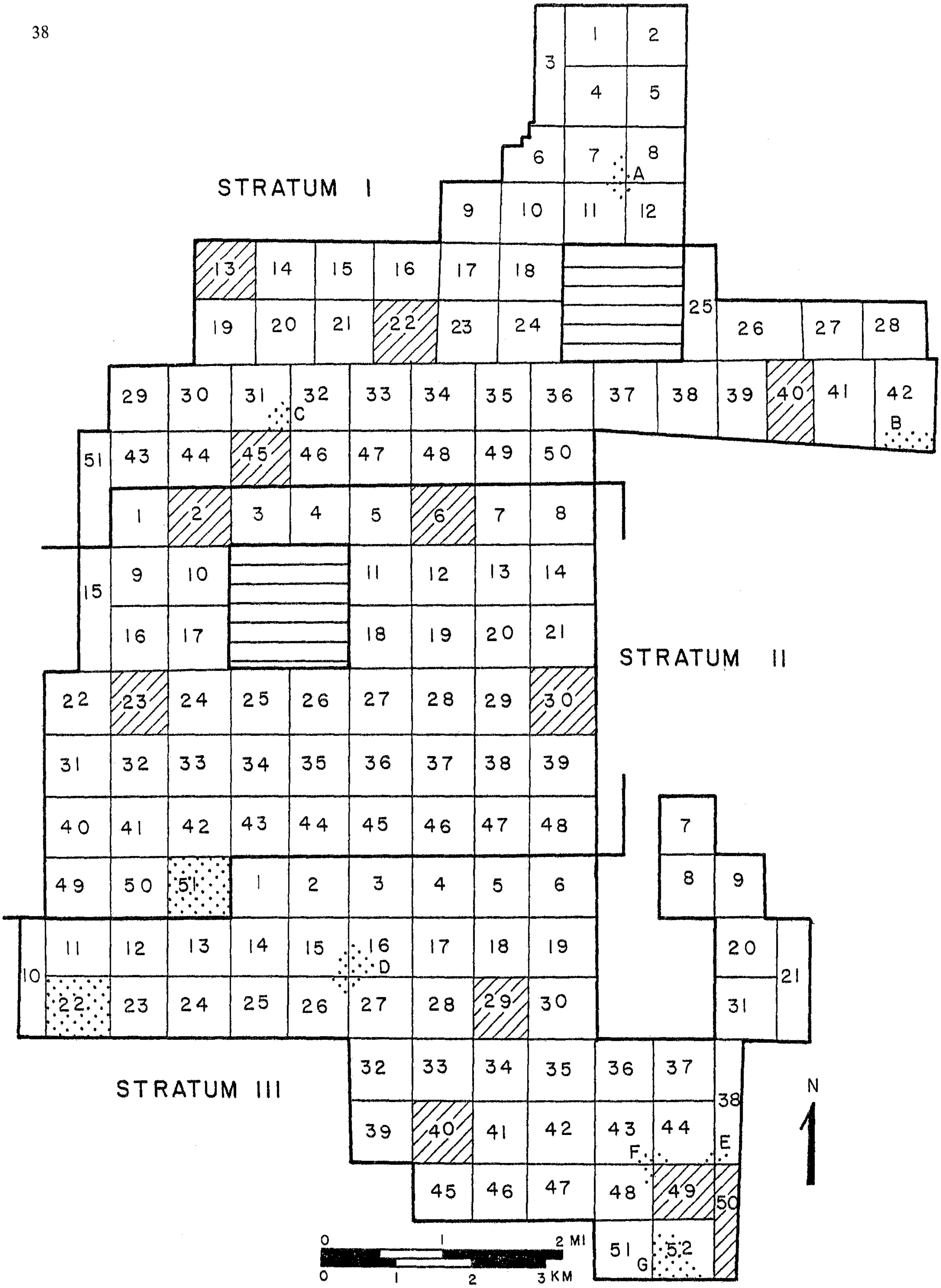

Figure 6: Sampling strata and units in the Redmond Training Area. Cross-hatched units were surveyed as part of the randomly drawn sample; stippled areas were surveyed as part of the purposefully drawn sample.

land), was to produce, test, and evaluate a predictive model of the distribution of archaeological resources. This would then allow the BLM to determine whether or not to renew the Oregon National Guard's lease of the property for training military personnel.

Because so little was known about the prehistoric human occupation of the High Lava Plains physiographic region (where the RTA is located), and because the ethnographic data were not very specific in this regard, our predictive model prior to fieldwork was rather general. The RTA was, consequently, broken into three equal-sized sampling strata on a north-south axis to increase the chances of a uniform distribution of sample quadrat units. As well, the RTA appeared to be extremely homogeneous in terms of physiographic variables, the only apparent potential variation emanating from a north-to-south gradient of increasing average elevation and distance from streams and rivers. We anticipated that this north-south environmental gradient might have been an important factor in prehistoric land use practices.

Four quarter-sections in each stratum were randomly selected, yielding a 7.7% sample of the RTA acreage. Two additional quarter-sections were purposefully chosen to fill a gap in the distribution of the randomly chosen units, and to test the predictive model derived from our 7.7% randomly chosen sample. The equivalent of one and a half other quarter-sections were also purposefully chosen to test our conclusions derived from the 7.7% random sample and to bring our total sample to the required 10% fraction.

Surface inspection of all selected areas was accomplished by pedestrian survey. Individual surveyors were placed 15 m apart as archaeological data collected prior to our work indicated that minimum site size tended to be 10 to 15 m horizontally. We walked north-south, back and forth, until an entire unit had been examined (Figure 7). All encountered artifacts were collected, numbered, and plotted on enlarged 7.5' USGS quadrangle maps. When artifacts appeared to occur in relatively dense concentrations, we stopped collection, examined the area in detail, and attempted to ascertain whether a distinct, dense cluster of artifacts (a "site") was present. Our definitive criteria for "sites" were rather subjective, but usually our sites tended to have five or more artifacts in each of several contiguous 2 x 2 m blocks. Several sites were completely surface collected and later analyzed. We suspect that our reconnaissance procedures gave us a maximum of about 20% of the isolated finds in any given survey unit, or, based on the 7.7% randomly drawn and sampled area, about a 1.5% sample of the total isolated finds in the RTA (see Table 2).

We examined 5,485 m^2 of site area intensively, and inspected 100% of 1,561,920 m^2 of off-site area (Table 2). I have manipulated our data to produce the following statistics: artifact density for on-site areas varied from stratum to stratum, but averaged 0.358 artifacts per square meter. Artifact density for off-site areas also varied from stratum to stratum, and averaged 0.000268 artifacts per square meter (see Tables 2, 3, and 4 for additional data).

While we would not argue that our sample is representative of the RTA as a whole, and in fact evidence presented elsewhere suggests it may not be (Lyman et al. 1983:324-331), what we have done is provided data for the eventual delineation of density criteria, the purpose of which is to define site areas and non-site areas. The applicability of these empirically determined criteria may be confined only to the High Lava Plains or to a portion of that region. Similar density data for the Steens Mountain area of southeastern Oregon (Beck 1984; Jones 1984) indicate that a different set of values for the same density variables is applicable in that area. Even within the Steens Mountain area, the values for the density variables vary from sampling stratum to sampling stratum, which are defined environmentally.

Importantly, if "density of artifacts in space" variables are used as criteria to distinguish site areas from non-site areas, the values of those variables must be established empirically as they will vary from region to region (cf. Tainter 1983). They can be established empirically, just as the chronological significance of the greater than-less than 8 mm value of the variable "projectile point neck width" was established in the Great Basin (cf. Corliss 1972, 1980; Thomas 1978).

If land managers desire to preserve a representative sample of the *total* variability in the archaeological record, they must consider the off-site as well as on-site areas. Our data from the RTA indicate the functional composition of artifact assemblages varies significantly between on-site and off-site areas (Figure 8). Similar conclusions were derived from the much larger samples recovered from the Steens Mountain area (Beck 1984; Jones 1984).

On a more substantive note, while our sample from the RTA may not be representative, it is intriguing to note the differences between the ratio of manufactured to expediency tools from off-site areas and that ratio for on-site areas. The ratio is 2:1 in the isolated find assemblage, and 0.4:1 for the site assemblage (Lyman et al. 1983:158). If our sample is even approximately representative, then it appears that relatively more energy was expended by prehistoric peoples on making tools for resource extraction (as represented by the off-site assemblage) than for

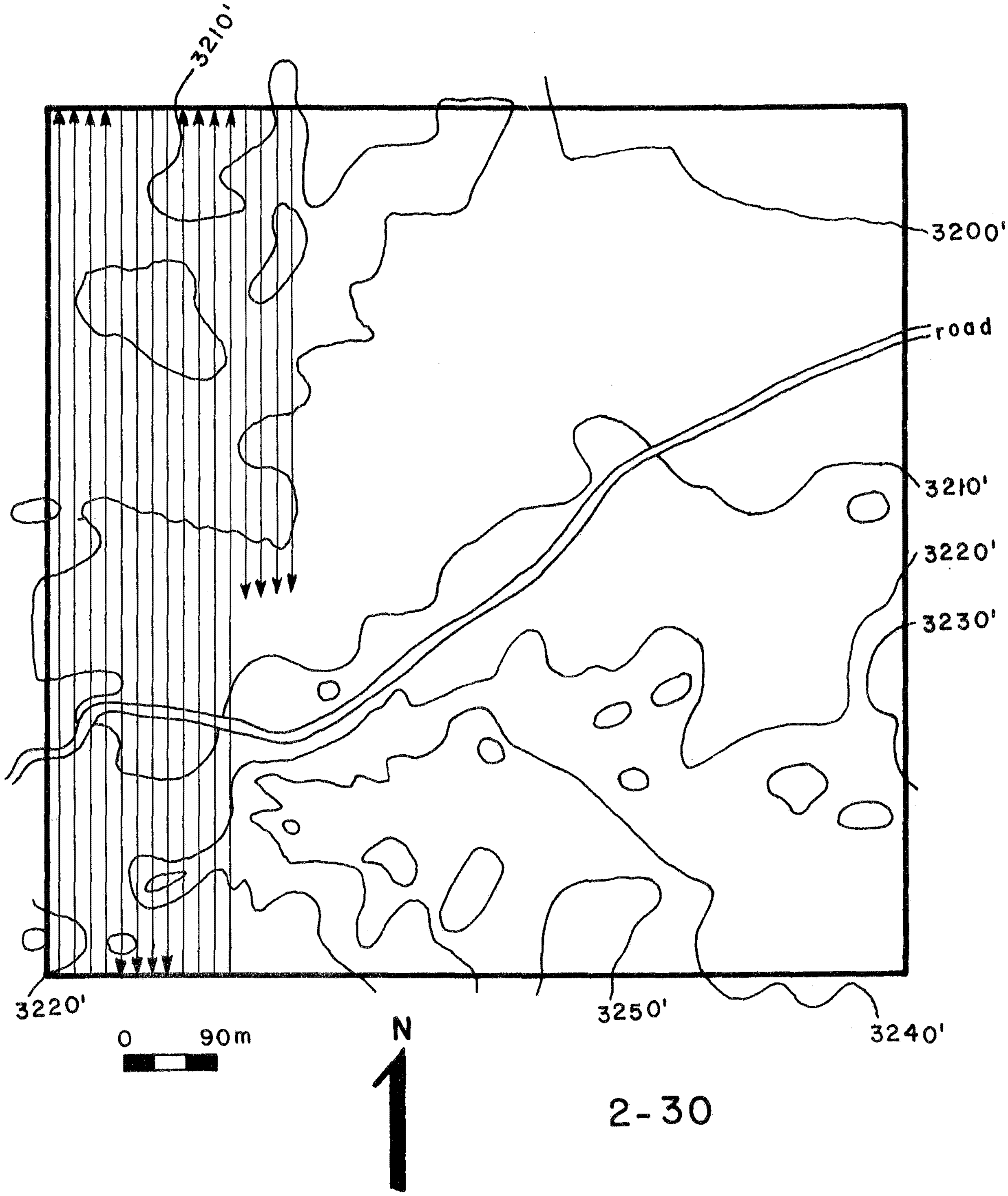

Figure 7: Survey procedure. Individual surveyors followed the paths indicated until the entire unit was examined. Flagging was tied to trees and bushes to insure no overlaps or skips in survey coverage.

Table 2: Spatial area artifact density for on-site and off-site areas in the Redmond Training Area (from Lyman et al. 1983). The data are for the randomly drawn 7.7% sample only (see text for discussion).

	Site size (m^2)			N of total artifacts/site			N of artifacts/2x2m		
Stratum	Range	$\overline{X}$	σ	Range	$\overline{X}$	σ	Range	$\overline{X}$	σ
1	102–705	404	–	30–70	50	–	10–12	11	–
2	400–1152	688	± 362	35–433	227	± 199	5–50	19	± 21
3	96–960	416	± 330	29-786	191	± 333	7–64	20	± 25
TOTAL	96–1152	516	± 350	29–786	178	± 246	5–64	18	± 20

Stratum	N of sites	N of isolated finds	N of site artifacts	Total artifacts	Total site area surveyed(m^2)*
1	2	65	100	165	652
2	4	155	908	1063	2572
3	5	198	955	1153	2081
TOTAL	11	418(17.6%)	1963(82.4%)	2381	5485

Stratum	Total non-site area surveyed(m^2)*	N of artifacts/m^2 on non-site areas	N of artifacts/m^2 on site areas
1	519,304	0.000125	0.153
2	516,582	0.0003	0.33
3	526,033	0.000376	0.459
TOTAL	1,561,920	0.000268	0.358

resource processing and consumption (as represented by the site assemblage). As we argued in the RTA final report:

> This makes sense from an adaptational perspective. Resource acquisition or procurement is more important for survival than resource processing, as processing can be efficient or to some degree inefficient and the organism doing the processing will survive. Inefficiency in resource procurement will ultimately result in the death of the predator organism. And, you have to have resources in order to process and consume them (Lyman et al. 1983:158).

Binford and O'Connell's (1984) recent ethnoarchaeological report on the Alyawara of Australia detected a similar difference in the distribution of manufactured and expediency tools.

The final point of methodological import is to note that all of the RTA materials, as well as the Steens Mountain materials, are surface finds. The surface archaeological record is, I would argue, quite often just as valuable as the subsurface record that we must excavate (cf. Lewarch and O'Brien 1981). The surface record is valuable in its own right, and not just as a phenomenon allowing the detection of subsurface archaeological materials (cf. Dunnell and Dancey 1983 and references therein). Thus, ignoring the surface record in favor of preserving only the buried cultural resources is inappropriate.[6] To argue that the surface record is more disturbed than the subsurface record (e.g., Wildesen 1984) is, on the basis of available evidence, a misinformed judgement (cf. Dunnell and Dancey 1983; Frink 1984; Lewarch and O'Brien 1981; Schiffer 1983; and Wildesen 1982 and references therein).

Table 3: Spatial area data for the Redmond Training Area (from Lyman et al. 1983)

SAMPLE UNIT	TOTAL AREA(m^2)	NON-SITE AREA (m^2)	NON-SITE AREA (m^2)	
1–13	646,416	102	646,314	
1–22	646,416	0	646,416	
1–40	658,125	0	658,125	
1–45	646,416	750	645,666	
		852	2,596,521	= TOTAL
			519,304	= 20% of TOTAL
2–2	646,416	0	646,416	
2–6	646,416	400	646,016	
2–23	646,416	800	645,616	
2–30	646,416	1552	644,864	
		2752	2,582,912	= TOTAL
			516,582	= 20% of TOTAL
3–29	646,416	0	646,416	
3–40	646,416	800	645,616	
3–49	646,416	321	646,095	
3–50	693,000	960	692,040	
		2081	2,630,167	= TOTAL
			526,033	= 20% of TOTAL
	Total sample:	5685	7,809,600	= TOTAL
			1,561,920	= 20% of TOTAL

Toward a Solution

I began this discussion of how our perception of the archaeological record has changed over the past two decades. I also noted some of the difficulties of implementing the federally mandated significance criteria. These issues are certainly not new, and have seen some discussion from a more legalistic perspective by Nurkin (1981) who notes that "significance" is defined inadequately in the National Historic Preservation Act of 1966, and that "archaeological resource" is defined inappropriately in the Archaeological Resources Protection Act of 1979 because it excludes arrowheads occurring on ground surfaces and excludes all archaeological resources on private lands. I think most of us are aware of the fact that different federal land managing agencies have adopted significantly different procedural guidelines (some appropriate, some not) for dealing with cultural resources on their respective lands (Meissner 1981). Given these very real and very relevant issues, then, is there a solution to the dilemma inherent in our attempts to conserve-preserve a representative sample of archaeological resources? In the context of my discussion thus far, I have mentioned two solutions suggested by others. I will now briefly reiterate and evaluate these solutions.

Archaeological Preserves

Lipe (1974) and Dunnell (1984; see also Dunnell and Dancey 1978), among others, have recommended that, given our modern perception of the archaeological record, the ambiguity of the significance concept, and the sampling paradox (the fact that we do not as yet have a complete inventory of all archaeological resources), we should attempt to establish archaeological preserves. That is, a representative sample of geographic space which includes *all* physiographic variability, should be set aside and the included archaeological resources conserved-preserved. Even granting that this might be feasible, which I doubt, the question then becomes one of sample size. How much acreage should be included in these preserves? Obviously, this question gains importance when it is realized that rarely occurring (one-of-a-kind) archaeological phenomena may not be included in the preserves. Clearly, the archaeological preserve idea is based on a statistical precision or spatial autocorrelation model of sampling rather than a discovery model (Nance 1983), and consequently rare elements may not be included in preserves. If the archaeological preserve solution were to be implemented on a statistical precision basis, allowances would have to be made for the rare elements not occurring on preserve lands. That is, we could

Table 4: Site area and artifact density data for sites in the Redmond Training Area (from Lyman et al. 1983). Note that only randomly selected units and their included sites have been listed here. See also Tables 2 and 3.

Site	N of Artifacts	Site Dimensions (m)	Site Area (m^2)	Max N of Artifacts/ 2 x 2 m Area
Stratum 1				
35DS174*	30	6 x 17	102	12
35DS175	70	25 x 30	750	10
Stratum 2				
35DS176	80	20 x 20	400	9
35DS179*	35	32 x 25	800	5
35DS177*	433	32 x 36	1152	12
35DS178	360	20 x 20	400	50
Stratum 3				
35DS183	50	20 x 20	400	7
35DS184	40	20 x 20	400	11
35DS186*	29	8 x 12	96	9
35DS187	50	15 x 15	225	8
35DS188*	786	30 x 32	960	64

*Surface material from these sites was intensively collected. All other sites were intensively examined and artifact frequencies were extimated. The two largest (most artifacts) sites were intentionally collected, but it is fortuitous that the three smallest (least artifacts) sites were collected and no mid-size (ca. 50–80 artifacts) sites were collected.

not ultimately write off all other nonpreserve acreage. Then the problems would be to determine what constitutes a rare element, and how to recognize one when we do not have a complete inventory of all archaeological resources on preserves.

It seems obvious that preserves would be on federal land only. The problem then becomes one of determining whether or not federal lands contain a representative sample of archaeological resources on *all*—public and private—lands. The sampling paradox would again appear to thwart our efforts to solve this problem. Thus, while I see the archaeological preserve as possibly circumventing some problems inherent in CRM today, I also see problems inherent in the preserve idea itself, problems that appear to perhaps be greater than the ones solved by this solution.

Objective Criteria

Dunnell (1984) and Wildesen (1984) have suggested or implied that a set of "objective" criteria be developed, the purpose of which is to evaluate the potential significance of any cultural resource. These criteria need to be directed from humanistic, as well as scientific, research perspectives (Dunnell and Dancey 1978). The latter must not be directed solely from a particular research design perspective because the particular research design used may preclude addressing research questions conceived in the future by today eliminating a resource relevant to that future question.

Sharrock and Grayson (1979) and Barnes et al. (1980) have suggested that, as mandated, the significance concept is sufficient to allow archaeological resources of all types to be preserved-conserved for future generations of researchers. Yet, it seems that current research designs will regularly be used to justify the significance decisions of today and thus dictate what is preserved for tomorrow (Glassow 1977; Goodyear et al. 1978; Raab and Klinger 1977, 1979; Klinger and Raab 1980; Raab 1984). The argument is that *if* (and this is a major IF) today's research designs are wisely constructed and are broad enough and flexible enough to allow for tomorrow's changes in research goals, then the result will be favorable (Raab 1984 and references therein). For instance, it has been suggested that the "State Plans" called for by the National Historic Preservation Act of 1966 should be updated and modified every year (Thompson 1979).[7] Clearly, however, even this approach may fail. For example, as we all know, archaeologists of the 1940's and 1950's operated mainly under the culture history paradigm and thus regularly failed to collect data relevant to today's research problems (cf. Dunnell 1984). Can we anticipate the nature of the neo-archaeology of the year 2,000 any better than the culture historians of the 1940's could predict the impact of Lewis Binford on the discipline (cf. Willey and Sabloff 1980)? I think we would be foolish to argue that we could.

Is There a Solution?

I have been rather critical in my discussion, and have ended up in a rather pessimistic position. I suspect the reason for this emanates from the literature I have read and my interpretation of that literature. In turn, I suspect that the tone of the literature I have read emanates from the perception, prevalent during the 1960's, that the archaeological record being destroyed so rapidly that we had to act quickly in order to have sites left to dig in the 1980's. The "do it today because tomorrow may be too late" syndrome apparent in the early writings of McGimsey (1972), Davis (1972) and others[8] from 15 to 20 years ago has carried over into many of our discussions today (e.g., Lipe 1974; Dunnell 1984). Thus, I suspect that solutions like establishing preserves and designing a set of objective criteria may be subconscious responses to a feeling of an impending and shortly imminent event of doom. Clearly, the archaeological record is being destroyed at an alarming rate, but I doubt archaeologists will be completely out of business in another 20 years. The destruction of the archaeological record does have a temporal dimension, and to propose a realistic solution, I have replaced the imminent doom perception with a perception of destruction as a long(er) term process. Given this perception as a first step, I can now move to the second step in offering a solution.

Have we built into the CRM legislation a paper tiger? Although clearly we may have in some respects (cf. Nurkin 1981), in others we have not (cf. King and Lyneis 1978). For instance, sites are deemed significant, and some of these are ultimately listed on the National Register and preserved, while others are conserved by data recovery. The significance concept, for all its ambiguities and tautologies, does appear to be working (Sharrock and Grayson 1979). I nonetheless think, as Tainter and Lucas (1983) suggest, that we must argue just as hard that particular cultural resources are *not* significant as we do that other resources *are* significant. If this is done wisely, I suspect that archaeologists will find very few nonsignificant sites, and thus we may ultimately—in the long term—accomplish what we want: preservation-conservation of a representative sample of sites, including rare elements.

In a similar vein, archaeologists must argue twice as hard for the nonsignificance of off-site areas as they do for site areas. They can no longer simply *assume* that the off-site record is not worth the time, effort, and money to consider. The value of the off-site record for studies of settlement patterns, subsistence systems, and land use practices is now quite apparent (Beck 1984; Jones 1984; Thomas 1975), but it is something that was not truly suspected as recently as the late 1960's. We cannot allow off-site areas to go unprotected, and we must establish empirical criteria for delineating on-site and off-site areas. Again, with well-informed reflection and wise argument, we will, I believe, certainly see more and more off-site areas—and their included isolated finds—being found to meet the National Register criteria of eligibility.

ACKNOWLEDGEMENTS

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NOTES

1. By "archaeological record" I mean all cultural resources, be they of historic or prehistoric age, standing or collapsed structures, artifacts (discrete objects), features, etc. (see Table 1).

2. Ambler (1984:142) makes a similar observation. In the context of describing the known archaeological record and how it is used within the context of constructing a predictive model, he suggests "a great deal of our existing data was gathered before anyone thought of recording

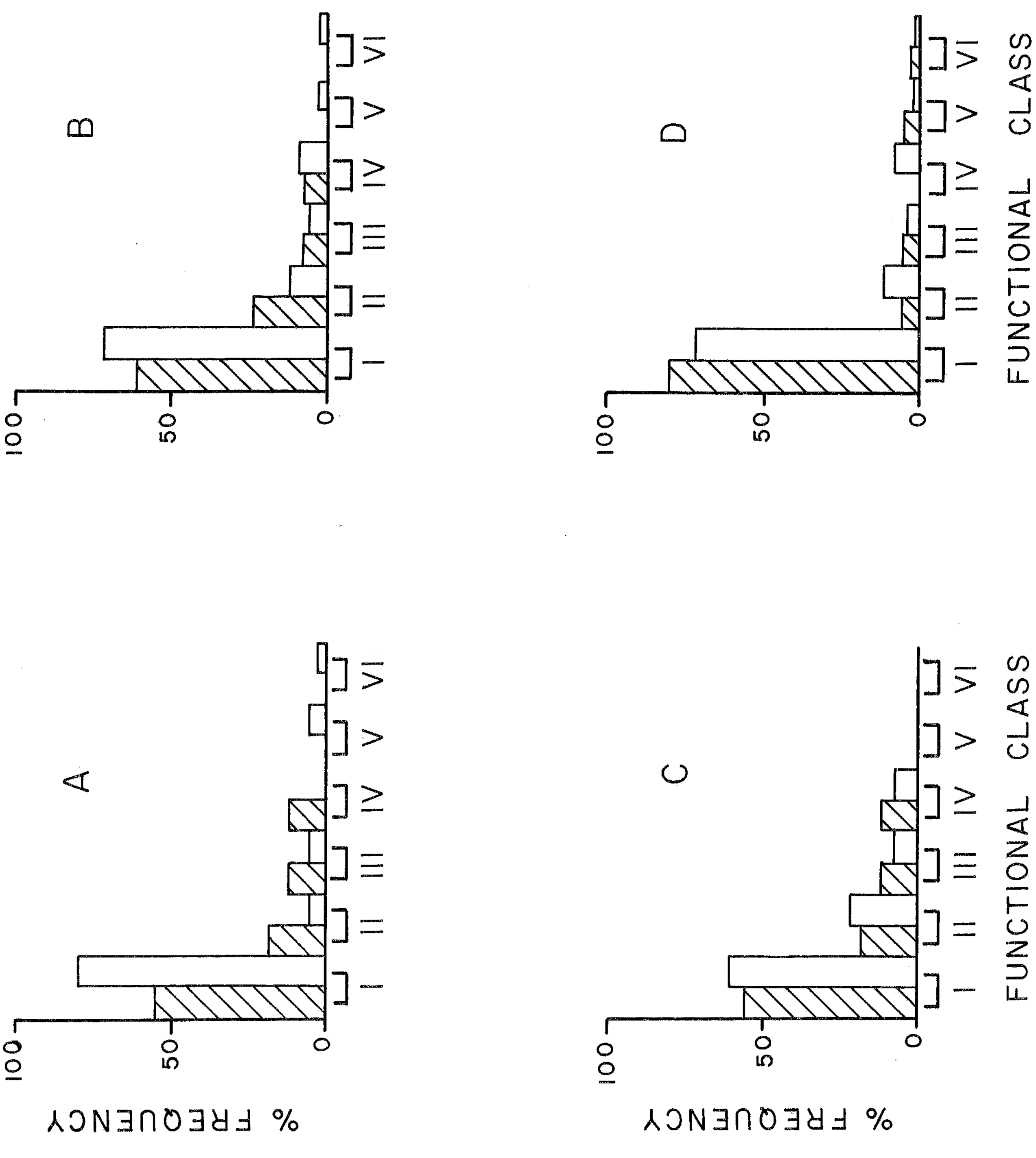

Figure 8: Frequencies of functional tool classes in two survey units in the Redmond Training Area. Functional classes are: I, scraping; II, cutting; III, scraping-cutting; IV, graving; V, scraping-graving; VI, drilling. A: quadrat 2-30, cross-hatched bars represent off-site assemblage (N of tools = 29), blank bars represent an assemblage (N of tools = 36) recovered from a site in quadrat 2-30. B: quadrat 3-50, cross-hatched bars represent off-site assemblage (N of tools = 13), blank bars represent an assemblage (N of tools = 101) recovered from a site in quadrat 3-50. C: comparison of off-site assemblages in A and B, cross-hatched bars represent quadrat 2-30, blank bars represent 3-50. D: comparison of on-site assemblages in A and B, cross-hatched bars represent site in quadrat 2-30, blank bars represent site in quadrat 3-50. These histograms illustrate that more scraping activities took place in on-site areas than in off-site areas, more cutting took place in off-site areas than in on-site areas, and all drilling activities took place in on-site areas.

anything other than standing masonry, much less 'limited activity loci,' as sites." Berry (1984) has recently summarized the statistical pitfalls of building predictive models on the basis of such nonrepresentative data as are generally available at present.

3. The fact that *any* site can be deemed significant is, of course, valuable (Sharrock and Grayson 1979) and may in fact be beneficial in the long run, as will become clear.

4. I here use the terms "conservation" and "preservation" simultaneously because the intent of the law is preservation while reality dictates that many management decisions concern conservation. To "preserve" something connotes maintenance of that thing as it now exists for an infinite time period. To "conserve" something connotes planned management of a thing, with its eventual use at some time in the future (i.e., preservation for a finite time period). See also Nurkin (1981:56).

5. For purposes of this discussion, I am assuming that discovering archaeological resources is not an insurmountable problem (see McManamon 1984 and references therein). This issue seems to me to be one that hinges on the sophistication and sensitivity of our techniques, and thus can be resolved as our techniques of site discovery improve.

6. For example, Nurkin (1981:52) has pointed out that the Archaeological Resources Protection Act of 1979 does *not* prohibit "the removal of arrowheads located on the surface of the ground" (16 U.S.C. 470ee(g)), and thus may "encourage the collection of arrowheads by pot hunters and private collectors." The uniform regulations for ARPA (49 F.R. 1215) attempt, in part, to remedy this problem by including in the definition of "archaeological resources" that are protected, "surface or subsurface artifact concentrations or scatters [including] weapons and weapons projectiles." It remains to be seen if these regulations are effective in protecting surface occurring isolated finds.

7. Oregon's Historic Preservation Plan (ORS 358.605 through 358.622) in effect simply proclaims that the State will inventory sites that are significant in Oregon history and prehistory, and prepare and implement a comprehensive statewide preservation plan. A draft statement from the Oregon SHPO archaeologist (Gilsen 1984) I have seen and understand to be a part of the state preservation plan is so broad and general that it provides no help for making significance decisions; effectively, it simply states that all cultural resources are potentially significant.

8. McGimsey (1972:3) presents the strongest statement of the syndrome in the first paragraph of his seminal book: "It is incumbent upon all persons knowledgeable about or interested in archaeology, to whatever degree, to do their utmost *now* to insure that the maximum amount of critical data is preserved" (emphasis in original). The tone of McGimsey's statement is found 11 years earlier in Brew's (1961) characterization of emergency archaeology as having been "conceived in nothing short of panic and nurtured by discouragement." The tone carries over from there into Johnson's (1966:1597) statement that "it is not possible to relax, for there is an increasing amount of [cultural resource] work to be done." The tone of panic is also found in Davis' (1972:267) assessment that "in the last decade, the amount of land alteration that adversely affects sites has increased at a rate far in excess of available resources for the rescue of [archaeological] information. The result is a crisis." Finally, the tone is found in Dekin's (1972:83) statement that "if [the present rate of destruction] of known and unknown sites continues unabated, we will have condemned us all to a future devoid of additional archaeological data."

USDA-FOREST SERVICE

INVENTORY AND LOCATIONAL

SITE MODELS

SURVEYING IN WESTSIDE FORESTED ENVIRONMENTS: PROBLEMS AND POTENTIALS

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Abstract

Problems inherent in surveying within the heavily forested environments of the Western Cascades are discussed. These include not only those created by terrain, geology and vegetation, but also the bias which may be introduced by the survey strategy used to locate sites. Since the majority of the projects on the Mt. Hood National Forest are proposed timber sales, surveys based on harvest unit areas can have biased results. By implementing a survey strategy which emphasizes project planning areas, the probability of discovering sites has been increased. This also promotes better project planning from a cultural resource management perspective.

Environmental Problems

Inventories conducted thus far on National Forest lands have usually been undertaken to help determine the effects of proposed projects on cultural resources. When conducting these project-related inventories, surveyors encounter the problems inherent in surveying within the heavily forested environments of the Western Cascades. These include not only terrain, geology, and vegetation but also the bias which may be introduced by the survey strategy used to locate sites. Without a thorough understanding of these problems our interpretation of the archaeological record will be skewed. This paper will discuss each of these problems and suggest potential methods for handling them, with examples drawn from the inventory program of the Mt. Hood National Forest.

The Mt. Hood National Forest covers over one million acres located on the northern end of the Cascade Mountains in Oregon (see Frontispiece). It is bounded on the north by the Columbia River, and on the south by the divide separating the Clackamas and Santiam drainages which forms the boundary with the Willamette National Forest. The Willamette Valley lies to the west of the Forest with the Columbia Basin to the east.

The major portion of the Forest falls within two physiographic provinces: the Western Cascades and the High Cascades. In the Western Cascades, gentle forested slopes border the Willamette Valley. These slopes become rugged with steep, dissected sideslopes in the higher elevations. The High Cascades have a rolling terrain interrupted by glaciated valleys and high volcanic peaks and cones. Elevations range from 11,235 feet on Mt. Hood down to 65 feet along the Columbia River. The average elevation is around 3000 feet. The major river systems represented on the Forest are the Columbia, Sandy, Clackamas, White, and Hood Rivers.

The terrain in the Western Cascades and areas of the High Cascades generate a problem of inaccessability due to the steep sideslopes. Over 55% of the Forest has slopes greater than 30%, and 15% of these areas have slopes over 60%. Areas of high probability for site occurrence cannot reasonably be surveyed when they are surrounded by large areas of steep sideslopes often covered by brush, causing difficult passage. The steep gradient of the rivers and creeks causes very high velocity flows during floods. This in turn has caused substantial changes in streamside topography innumerable times during the last several thousand years. The flood of 1964 (a 100-year event) washed away half of the creek bench on which is located one of the tollgates for the Barlow Road, a segment of the Oregon Trail opened in 1846. Thus many high probability streamside areas have been radically altered.

Related to terrain is the geological history of the High Cascades Province (Crandell 1980). Geologic events have overlain the evidence of prehistoric occupations. The Timberline eruptive period of Mt. Hood occurred from 1500 to 1800 years ago. This eruptive phase created the large debris fan on the south slope of Mt. Hood that extends to the base of Multopor Mountain over five miles away. Mudflows followed the Sandy River down to its confluence with the Columbia River. Deposits are over 200 feet thick four miles from the summit and over 20 feet thick at the Zigzag Ranger Station on the western edge of the Forest located eleven river miles from the summit. Mudflows also occurred down the White and Zigzag Rivers and adjacent creeks. Ash deposits vary from six inches to over two feet thick on the south, east, and northeast sides at distances up to six miles from the summit. The Old Maid eruptive period occurred only 200 to 300 years ago. Coarse mudflows formed Old Maid Flat

in the Sandy River Valley. Remnants of trees buried in this flow indicate a mature forest was growing at the time with trees over three feet in diameter. Today this area is covered by small lodgepole pine. Pyroclastic flows and mudflows occurred down the White River also. Ash deposits were laid down on all sides of the mountain. During this same period the Hood River Lava Beds flowed down a branch of Hood River from a crater at the base of the mountain's northeast slope and are over three miles long and up to a mile wide. The geologic events of Mt. Hood have masked the probability areas for prehistoric site occurrence along its flanks. Rivers and creeks flowing off of Mt. Hood have deceptively level valley floors which would normally be considered high probability areas, but these surfaces may be only 200 years old. The surrounding ridges are covered by ash deposits. Discovery of prehistoric sites while surveying these areas is obviously unlikely.

The average annual precipitation on the Forest can be as much as 170 inches per year (Howes 1979). West of the Cascade crest temperate conditions have resulted in a very dense vegetational cover. The major ecological zones represented are western hemlock, pacific silver fir, and mountain hemlock. Except for the upper limits of the mountain hemlock zone these ecological zones provide a basically solid forest cover. Meadows tend to be wet and relatively small and many represent the drying stages of old ponds and lakes. Knowing where resource areas (such as huckleberries) are today does not tell us where they were thousands of years ago. These areas cannot be considered as permanent fixtures of the landscape upon which to base a survey strategy that is meant to locate sites of all ages. Forested vegetation can also influence access to an area by making passage through it difficult if not impossible. Trying to deal with steep slopes plus tall, scraggly growths of rhododendron is not only frustrating but dangerous to one's health. Some stream benches at the foot of slopes have high water tables giving rise to luxuriant growths of devil's club, a very aptly named plant. Where access is not a problem, low growing vegetation can completely cover the forest floor. Openings at high elevations can be densely covered with beargrass. Where the forest canopy is completely closed undergrowth is lessened considerably but forest debris and the ever-present duff layers still prevent one from observing much soil. Duff layers over eight inches deep have been encountered.

Survey Strategy Problems

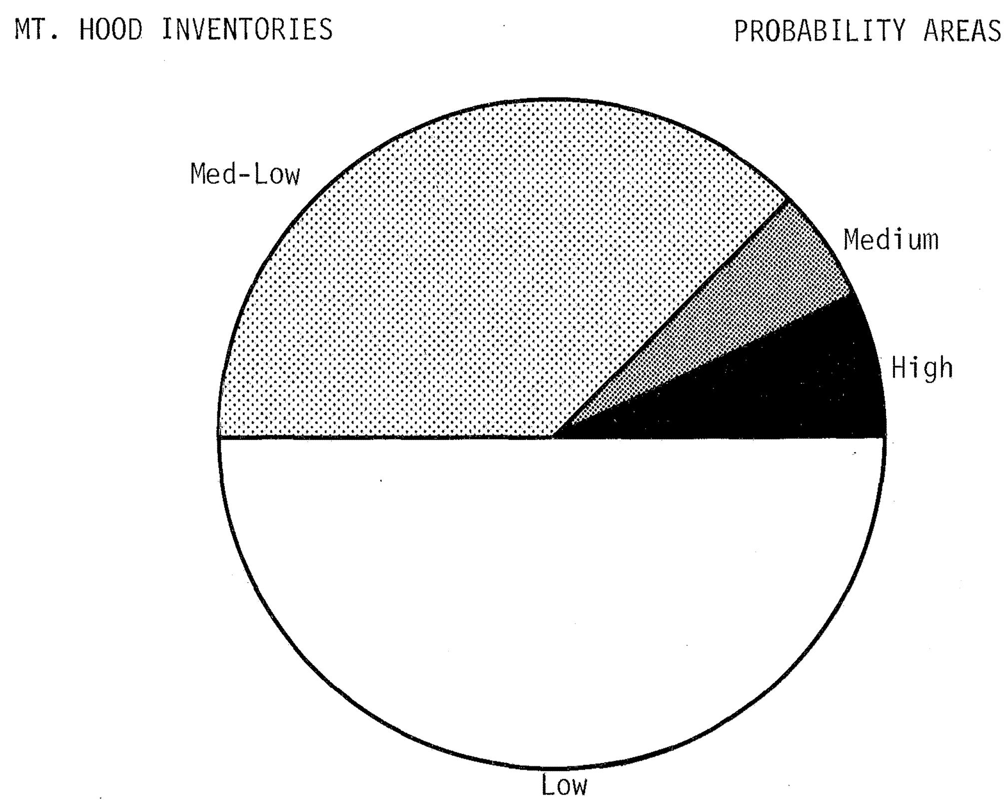
The type of survey strategy used can also introduce a bias into the data gathered. Before surveys were begun on the Forest only one or two prehistoric sites were known to exist. The general opinion of archaeologists questioned at that time was that the Cascades probably received little intensive use by prehistoric populations. Sites would tend to be so small and sparse that they could add little of importance to our knowledge of the area's prehistory. This rather negative belief naturally prejudiced the views of the surveyors. Not expecting to find any sites, they were not surprised when none or few were discovered.

The type of coverage an area receives will also influence the outcome of the survey. Examination of impact unit surveys completed before the Mt. Hood Sample Survey Design was developed showed that almost 50% of the areas covered by the surveys were in low probability areas for site occurrence. Not quite 10% of the areas covered contained high probability areas (Figure 9). Thus site discovery was infrequent, leaving an impression that prehistoric occupation and use was rare. Although areas thought likely to contain sites were thoroughly searched, areas thought less likely were given less intensive coverage. That is, survey routes were spread further apart, lessening the likelihood of discovering small, sparse lithic scatters. Thus these earlier surveys were biased towards larger, dense sites occurring in low frequencies.

Although certainly lacking in quality and quantity, these data were used to help formulate a Sample Survey Design in 1982 (Marvin 1982). The purpose of the design was to concentrate field survey efforts in areas where sites are more likely to occur. Other less likely areas are sampled, but where field survey takes place the area receives 100% coverage. This helps correct for the bias of the earlier surveys. The results of the first year in using the Sample Survey Design were gratifying in the increased number of sites discovered. These additional data showed that the Sample Survey Design needed to be revised and this was completed in 1983 (Marvin 1983).

The Sample Survey Design chosen for the Mt. Hood National Forest's inventory program is a proportional stratified sample (Blalock 1972). The stratified design was chosen because of the prior knowledge gained from the past surveys conducted. The proportional method was chosen because the strata should be weighted (and surveyed) in relation to their representation in the survey area and in correspondence with the probability of the strata containing sites. The underlying assumption of the design is that the locations of prehistoric sites are correlated with environmental characteristics rather than being randomly scattered over the landscape.

The Sample Survey Design emphasizes surveys of project planning areas and will undertake surveys of subdrainages when these are used for project planning beginning in 1986. This has resulted in a reversal in the type of area covered as compared to the earlier surveys under-



IMPACT	High	Medium	Med-Low	Low
	8.5	5.4	36.0	49.9

Figure 9: Representation of probability areas in surveys of project impact units.

taken. Low probability areas represent about 10% of the acreage covered and high probability areas represent over 40% (Figure 10). The actual number of acres being walked remains about the same. We have also doubled the number of Native American sites found per year when compared to the earlier surveys.

Preliminary analysis of the data available for Native American sites indicated three significant associations with environmental variables: slope, geomorphic features, and distance to water. Other environmental variables examined during the analysis included type of water source, elevation, general ecological zone, soil depth and drainage, aspect, and specific vegetation on the site. Many of these other variables are interrelated and some are strongly associated with certain kinds of sites, but none were found to consistently predict the relative probability of site occurrence. The possible age of the site, its size and cultural materials present based on the survey data were also recorded to provide information for an ongoing subsistence/settlement study.

The interrelationships of slope, geomorphic features, and distance to water defined the high, medium, medium-low, and low probability sampling strata (see Table 5). The sampling size of each probability area was based on the quantitative occurrence of Native American sites. Table 6 illustrates the distribution of different site types across the probability sampling strata using data from sites recorded through 1984. For example, saddles were included in the high probability sample stratum because numerous sites have been found in these locations, whereas few sites have been found on ridges outside of the saddles. The sites found since 1983 indicate that the Sample Survey Design again needs to be refined or possibly subdivided into two different strategies: one for the westside and one for the eastside.

Since historic site locations are quite often dependent on cultural factors that may override environmental concerns, Euro-American sites are incorporated into the Sample Survey Design through use of a District Site Atlas (data are currently being gathered on historic sites to test this assumption). The Site Atlas has all historic structures, including trails and old roads, noted on old maps and records of the Forest. Other documents, maps, aerial photographs, etc. are also reviewed for potential sites. These locations are noted on the project planning area topographic map as being in the high probability survey stratum.

Identified strata are delineated on the project's topographic map. Acreages are calculated for each stratum and subtotaled for each sampling area, which then determines the number of acres to survey based on the sample size. For samples of less than 100%, areas selected for survey are chosen by applying the proportional stratified sample design. Thus, if the sample size is 20% (as for the medium-low sample), then 20% of each individual area identified for that stratum is surveyed. Actual acreages covered are adjusted in the field survey to make allowances for inaccessability and inaccuracies shown on the topographic map.

The specific areas selected for survey within each stratum receive complete ground coverage during the survey. Transects are generally no more than 100 feet apart. Walking straight lines at compass bearings at specified intervals are not undertaken. Rather, meandering routes which take advantage of surveying any visible soil surfaces are preferred as a more effective means of discovering sites. Obscuring vegetation is cleared at intervals to search for cultural materials in those areas where the surveyor's past experience indicates a very high probability for site occurrence. The dense ground cover also makes it necessary to resurvey areas that have undergone survey in the past and to conduct monitoring of ground disturbing projects.

Although the Sample Survey Design recommends ground clearings for removing obscuring vegetation, it is left up to the surveyor's judgement when to undertake such work. No data have been collected concerning the amount of time spent and the percentage of positive versus negative results of ground clearings. Negative results cannot guarantee that a site is not present. Clearings have been done on some sites which indicated few if any cultural materials. Testing done in the same locations as the clearings indicated moderately dense to very dense sites. Although the advantages of such clearings are obvious, the impact of the disadvantages in terms of time and unreliable results needs to be examined.

The role of project monitoring should be increased. When and where to monitor needs to be formalized and more thoroughly documented. It should not be left in such vague terms as "resurvey high probability areas within two years after project completion." This may not gain us much more information than the original survey. Clearcuts can be more heavily vegetated one year after they are cut than when the trees were standing. Timing is critical when conducting project monitoring. Road construction should be monitored right after the route is bladed through, before it is leveled and graveled. Harvest units should be resurveyed immediately after the prescribed burn is completed. Units with lop and scatter fuel prescriptions can be more obscured than before the units were harvested, making resurveying impractical. Of course, the type of yarding technique or other project activity and the probability of site occurrence must be taken into account. Areas to be tractor yarded provide the most clearing, but they result in the most disturbance

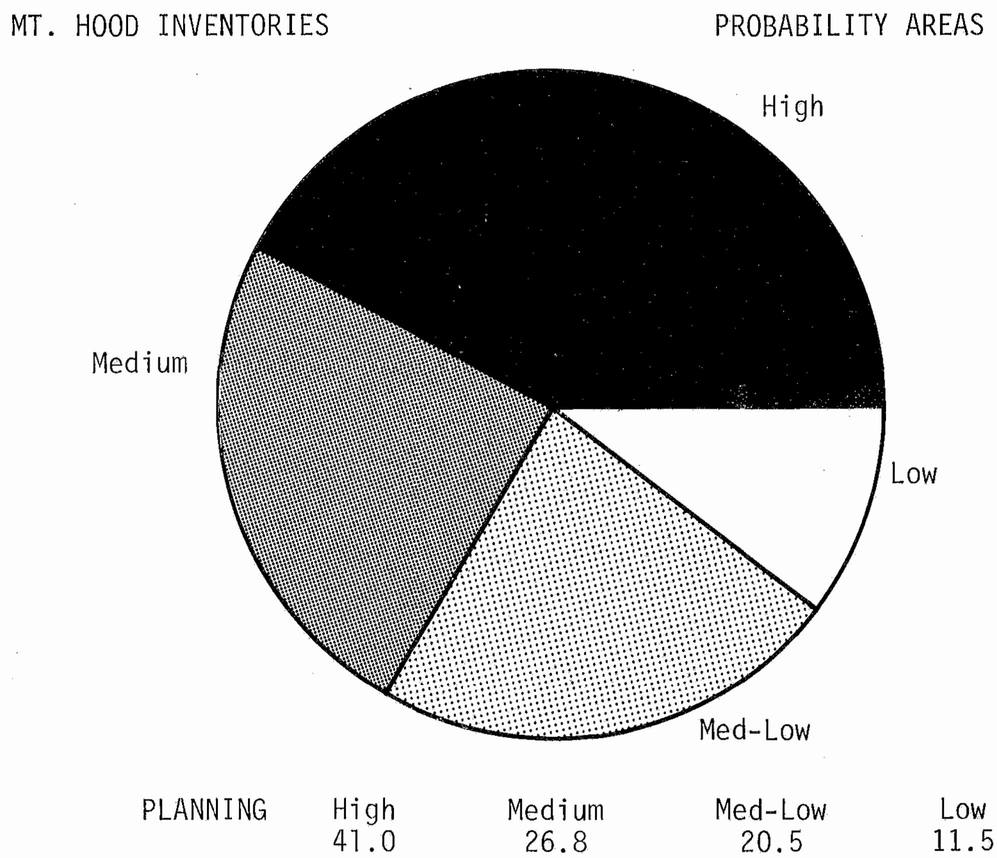


Figure 10: Representation of probability areas in surveys of project planning areas.

Table 5: Definition of probability sampling strata.

High Probability Sample	
H1	Potential prehistoric or historic sites as determined by records search and Site Atlas.
H2	Stream bottomlands and benches which have 20% or less slope and are within 300 feet of a water source. Second order and higher streams are included.
H3	Creek headwaters which have 20% or less slope and are within 300 feet of a water source. First order streams are included.
H4	Flat or gently rolling terrain which has 20% or less slope and is within 300 feet of a water source.
H5	Saddles which has 20% or less slope. Distance to a water source is not a factor.
H6	Rock outcrops on ridges which have 20% or less slope. Distance to a water source is not a factor.
H7	Cliff faces which may contain rock shelters, rock overhangs, or rock art. Slope and distance to a water source are not factors.
Medium Probability Sample	
M1	Stream bottomlands and benches which have 20% or less slope and are more than 300 feet from a water source.
M2	Creek headwaters which have 20% or less slope and are more than 300 feet from a water source.
M3	Ridges, spur ridges, and isolated ridges which have 20% or less slope. Distance to a water source is not a factor.
Medium-Low Probability Sample	
ML1	Flat or gently rolling terrain which has 20% or less slope and is more than 300 feet from a water source.
Low Probability Sample	
L1	All geomorphic features which have slopes greater than 20%. Distance to a water source is not a factor.

and are most likely to occur in areas highly probable for site occurrence. The advantages and possible disadvantages must be carefully weighed and considered.

Finally, one problem remains when surveys are limited to only those lands involved with proposed project areas. Large tracts of land on the Forest are not being surveyed for sites because no ground disturbing projects of any scope occur in these areas. They include lands which differ substantially in their characteristics from lands being surveyed. These include such areas as the face of the Columbia Gorge and its uplands, Wilderness areas, and the high lakes country on the south end of the forest. Without data from these areas our understanding of the archaeological record and interpretations of it will remain incomplete and biased.

Table 6: Distribution of site types across probability sampling strata.

			SITE	TYPE			
Stratum	Dense Lithic	Sparse Lithic	Rock Cairns	Peeled Cedars	Rock Shelter	House Pits	Total
H1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H2	10	8		9	2	?	29
H3	1	7		10	1		19
H4	2	3					5
H5	2	11	1				14
H6			12				12
H7							0
Total	15	29	13	19	3	0	79
M1							0
M2		1					1
M3	1	3					4
Total	1	4					5
ML1		3					3
Total		3					3
L1							0
Total							0
Grand Total	16	36	13	19	3	0	87

STRATIFIED INVENTORY SAMPLE SYSTEM: AN INTUITIVE SAMPLE DESIGN

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Abstract

With the onset of the Forest Service Cultural Resource Program in 1976, Forest Service archaeologists were faced with the task of integrating a new resource concern into a well-established system. Eight years later, the inventory system used on the National Forest is essentially the same intuitive model originally selected. The model was developed in response to the overwhelming task of inventorying hundreds of thousands of acres in the long term, but only planning on the short term by individual projects and 12-month appropriations. Several choices were available including random survey of large tracts, selected inventory of areas with direct impacts, and intensive transects with subsurface testing of areas with direct impacts to mention a few. On this forest, we selected the stratified survey of large tracts.

With the enactment of various Federal antiquity laws during the last 80 years, the role of Federal Manager has moved from interested spectator to an active participant in the management of our National Heritage. In the Pacific Northwest Region of the USDA-Forest Service, 5,032,000 acres have been inventoried since 1974, with thousands of sites recorded. This clearly puts the Forest Service in the center of the management of archaeological resources in the Pacific Northwest. Among the questions of interest here are: first, given this immense responsibility, how has the Forest Service responded to this task? Second, given the quantity of data recorded, what direction is the Forest Service Cultural Resource Program heading? Third, how are the individual management units, the National Forests, responding to this program? This paper will focus on an individual National Forest, the Wallowa-Whitman, and our reaction to the national and regional policies of the Agency.

From the onset of the Forest program (about 1978), the initial task, to identify the resource, has been the central focus of exchange between the Forest Service Manager and the Forest Service Archaeologist. Because the need for the demarcation of cultural resource areas is a management concern, the manager required the professional services of an archaeologist. the initial task in the CRM process is the identification of the resource. In archaeological terms, this means locating the "site" or focus of prehistoric activity.

So it is the empirical observations of patterns of discard of prehistoric societies by an archaeologist which draws cultural resource managers, cultural resource specialists, and the research archaeologists together in a framework of mutual exchange. The Forest manager is interested in the preservation and/or protection of the resource; the Forest archaeological specialist is charged with data collection, evaluation, and recommending appropriate preservation and/or protection measures; and the research archaeologist is dependent upon the data generated by the process for the continuation of the science. One might note here that the Forest archaeological specialist is often also a research archaeologist and dependent on regional and national research efforts in order to do appropriate site evaluations and make management recommendations.

Thus, the central issue of the entire consultation process (as defined by 36 CFR 800) is locating and caring for a cultural resource. This process requires one to know that the resource exists; further, 36 CFR 800 directs us to "conduct the appropriate studies and to provide the information necessary for an adequate review of the effect a proposed undertaking may have on a National Register or eligible property." These studies must be done as early as possible and before a decision is made to take any action that may foreclose alternatives or the Advisory Council's ability to comment on the impacts of a federal action on an eligible site. What we are really doing then is locating sites so that these sites may be managed.

At the Forest level, these regulations translate directly into a field inventory or field survey of the area of a proposed Forest Service undertaking. The nature of the field inventory then is a critical aspect of whether or not the Forest complies with both the intent and the spirit of the National Historic Preservation Act. Through our Forest Service manuals and policy guidebooks, the Forest Service has recognized three basic kinds of inventory: (1) overview; (2) the partial field inventory; and (3) the complete inventory.

The *overview inventory* is designed to document existing knowledge, describe gaps in the knowledge, and the recommended ways to fill those gaps. The *partial field inventory,* since it fills no legal requirement and only gives one a general indication of the existing resource, is rarely used; the *complete inventory* is designed to provide a full record of all locatable resources, meet all legal requirements, and is therefore the required inventory to comply with 36 CFR 800 (the Pacific Northwest Region definition of these inventory types is included in Cultural Resource Management Guidebook, 1983). In order to meet the existing regulation and Forest Service policy, the inventory for a typical Forest Service undertaking must, by definition, be a *complete inventory.*

This brings us to a discussion of the Stratified Inventory System as used by the Wallowa-Whitman National Forest. From a practical viewpoint, the inventory workload on the Wallowa-Whitman National Forest is heavy. In 1983, the Forest inventoried 78,000 acres; in 1984, 88,000 acres; and in 1985, 100,000 acres is the Forest target.

From the onset of the program, Forest management insisted the program must fulfill at least two criteria: first, the work must meet the legal requirements previously discussed, that is, find all of the locatable resource; second, of course, the work must be performed within the budget allocation for it. From a practical viewpoint, the Forest specialist needed to develop an inventory strategy which does both.

The system currently in use on the Wallowa-Whitman is the Stratified Inventory System (SIS), which was developed to meet the legal needs for complete inventory without forcing us to inventory 100% of each project area or to do only scientifically uninteresting areas such as cutting units, road rights-of-way, and other direct impact zones. Note here that rather than inventory to locate the resource, another choice was available. This choice is to look only in areas of direct impact to be sure the resource was not present before proceeding with the undertaking. This opposite approach is not scientifically interesting and would be more costly in the long run since it would require repeated adjacent surveys for each impact zone.

The first step was to develop an initial plan for the locations of cultural resource sites. Our initial assumption that all areas of the Forest not have equal probability for the occurrence of a prehistoric site is well documented in the archaeological literature. The existing site records, geomorphological and biological data, and ethnographic sources were combined into an intuitive preliminary inventory design. This design developed the following levels of physical areas where sites could occur.

Those areas identified were divided into levels of probability using all of the previously mentioned geomorphological, environmental, and cultural information (Table 7). These areas will be tested during one inventory year (i.e., the four-month field season of 1982, 1983, 1984). These data will be evaluated in the winters of 1984 and 1985 with a new survey design programmed for June 1985.

Some of the variabilty in the areas to be inventoried can be seen in Table 8. Of this area, 1.4 million acres have slopes exceeding 35%. Of these forest lands with slopes less than 35% (0.861 million acres), 0.617 million acres are forested, and 0.212 million acres are in grass and shrubs. The topographic variabilities range from valley bottom to high elevation rock peaks adding to the diversity of the environment.

The intent of this system is to inventory 100% of those areas where cultural resource sites are known to occur. These areas will be the junction of those features (environmental, cultural, physiographic, and so on) which indicate the probability of a site having been formed and preserved.

The composition of the inventoried areas may vary according to the project. In some areas where adjacent cultural resource inventories have not been performed, an initial set of inventory areas could be defined based on overview research or even hypothetical characteristics drawn from a similar or adjacent regions.

From this discussion, it should be clear that we do not sample sites, but rather inventory those areas which should contain most of the cultural resource sites. In addition, we look at 5% of the balance of the terrain to insure our sample is adequate. Using the 5% low probability sample as a test (of representativeness), we expand our inventory, if needed, to include areas where sites are discovered, but not predicted. Each of the areas within the 5% sample can be weighted using a simple weighting formula.

Assigning the variable weight to the survey allows the specialist to vary the emphasis of a survey to conform to a specific project area. If any of the geomorphological features are missing, they can be ignored. In an area with well developed ridge lines, these can be examined in detail. The only limit is the area under study.

The inventory process involves: (1) defining the 100% stratum; (2) defining the 5% stratum; (3) weighting the stratum elements if needed; (4) measuring the areas to be surveyed to document the sample size; and (5) initiating the field work. The worksheet (Table 9) shows a typical survey area.

Table 7: Criteria for definition of probability zones.

High Probability	
H1	The location of previously reported sites, ticklers, and geographic ticklers.
H2	The length of linear sites such as trails, historic trails, and roads, ditches, and railroad right-of-ways.
H3	Areas adjacent to springs and other isolated water resources such as lakes and ponds.
H4	Benches and terraces adjacent to the confluence of second order or higher streams.
Medium High Probability	
MH1	Areas adjacent to second order or higher floodplains where sites may be preserved.
MH2	Major ridge systems, including saddles.
MH3	Geologic formations known to possess caves, overhangs, or boulders which may contain evidence of human occupation or rock art.
MH4	Geologic formations known to possess mineralized zones which are characteristically associated with evidence of historic mining activities, e.g., ditches, tailing, tunnels, camps, etc.
MH5	Geologic formations which characteristically yield lithic raw material for tool manufacture by prehistoric people.
MH6	Ponderosa parklands located adjacent to areas of known prehistoric habitation sites.
MH7	Prominences offering a panoramic view.
Medium Low Probability	
ML1	Feeder ridges which are useful for both historic and prehistoric transportation systems.
ML2	Isolated or discontinuous ridges.
ML3	First order floodplains with high surface visibility and floodplain development.
ML4	Open slopes of less than 15%.
Low Probability	
L1	First order floodplains with dense vegetation and without floodplain development.

L2	All slopes greater than 15%.
L3	Alpine ridge systems.
L4	Vegetated slopes less than 15%.
L5	Vegetated slopes greater than 15%.
L6	Known areas of surface disturbance such as road cuts, quarries, etc.

Inaccessable Areas

IA1	Areas under water, e.g., lakes, reservoirs, stream channels, and marches.
IA2	Areas covered by gravel piles, spoil piles, and other temporary conditions.
IA3	Areas under paved roads, parking areas, man-made developments, and administrative areas not to be affected.
IA4	Areas under recent geologic activity such as land slides.
IA5	Lodgepole stands with dense areas of blowdown. These areas are impossible to transect and also represent a high risk to surveyors from falling trees or injury while climbing over fallen trees.

Table 8: General Land Classes*

	Forested Deep Soils	Forested Shallow Soils	Grass/ Shrubs	Non-Veg	Total
Less than 35% Slopes	617.10	23.76	212.93	6.98	860.77
More than 35% slopes	688.24	66.84	671.27	56.68	1483.0
Water	0	0	0	5.39	5.39
TOTAL	1305.34	90.60	884.2	69.05	2349.19

*Numbers in thousands of acres

The 100% survey areas were defined with reference to the known regional history and archaeology. They include all High, Medium High, and Medium Low areas. The selection technique is flexible to incorporate new information or delete proposed areas if sites are not found. The areas inventoried varied to include both historic and prehistoric sites, as well as special or rare sites such as historic mining or prehistoric lithic resource sites.

The areas surveyed are shown on Figure 11 which is marked with codes according to the SIS probability areas. During the entire process, 14 sites were located and recorded. This project inventories 972 acres of the 3,713 total project area, or 26.1% of the area.

The results of using the SIS system for the past three field seasons has been generally successful with regard to meeting the two original goals. That is, the resource is being located and protected, and the program has operated within the allotted budget.

Table 10 shows a few typical projects that were inventoried using the SIS system. Because of the varying amounts of high probability areas, the average percentage of area inventoried totals 50.7%, which is above the 20% minimum agreed to with the SHPO.

To date on the Forest, in excess of 4,500 cultural resource sies have been located during the process of inventorying 80,000 acres.

In general, we believe the SIS process has allowed the various Forest Service undertakings to proceed while we have protected the cultural resource sites from impact. The updated version of SIS is planned for the field season beginning in June 1985.

Table 9: SIS inventory data for a typical project area of 3,713 acres.

High Probability		
– H1	Reported sites	13 acres
– H3	Springs	2 acres
– H4	Confluences	53 acres
		68 acres
Medium High Probability		
– MH1	Second order floodplains	136 acres
– MH2	Major ridge system	47 acres
		183 acres
Medium Low Probability		
– ML2	Isolated ridge	377 acres
– ML3	First order floodplains	95 acres
		472 acres
Low Probability		
– L4	Vegetated slopes < 15%	144 acres
– L5	Vegetated slopes > 15%	105 acres
		249 acres
Total Area Surveyed		972 acres

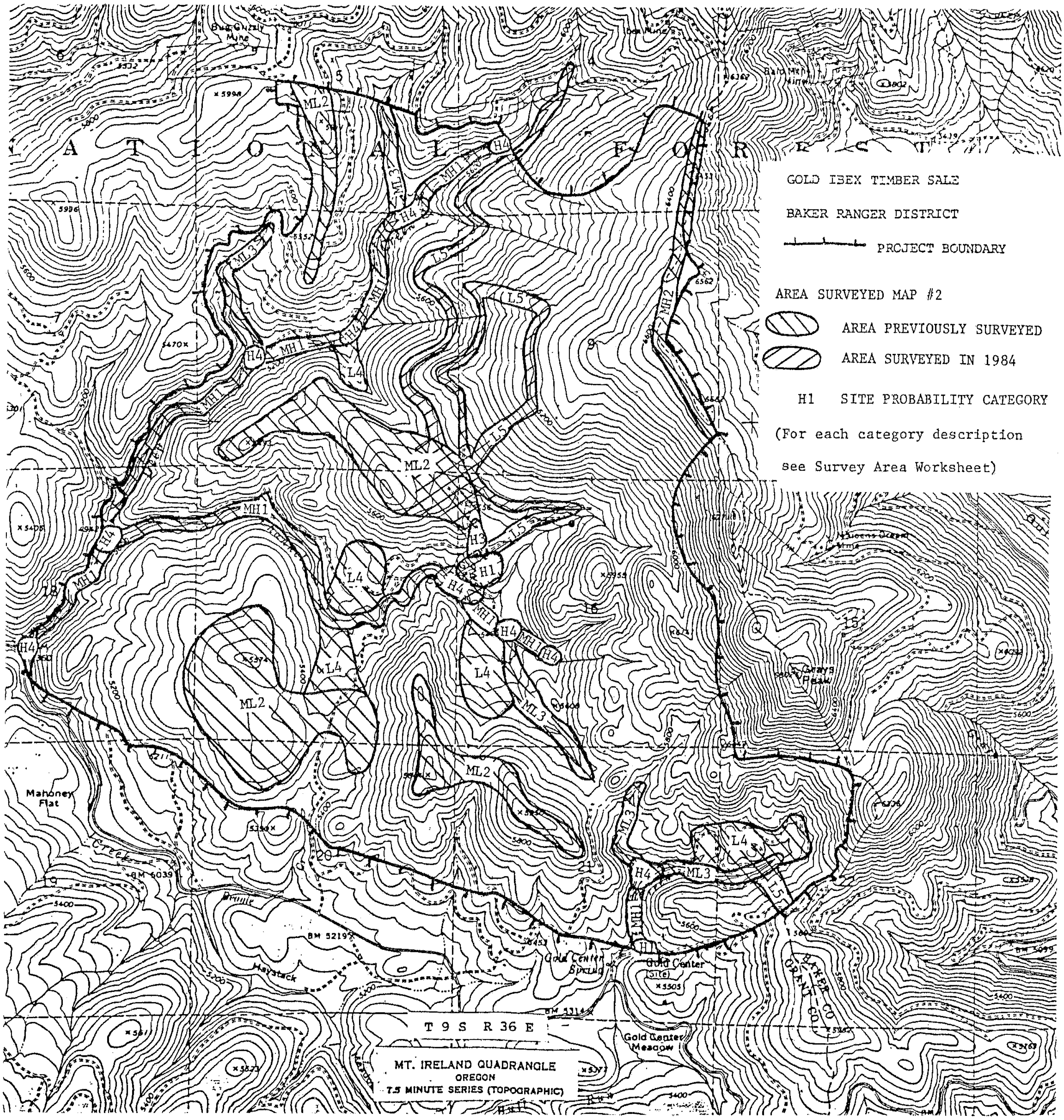

Figure 11: Area surveyed for Gold Ibex timber sale, showing SIS probability areas.

Table 10: Average inventory data.

Timber Sale •District	Inventory Data (see key below table) A	B	C	D	E	F
Blue Bird T.S. •HCNRA	6230	1574	4656	46	25	17
Roberts T.S. •Wallowa Valley	4575	1530	3045	50	33	28
Trillium T.S. •HCNRA	300	300	0	50	100	10
Gross Bug Lodgepole •Salvage •Wallowa Valley	216	189	27	12	80	4
Five Dollar Salvage •Wallowa Valley	500	325	175	6	60	1
Larch-Tele T.S. •Unity	5645	1165	4480	250	20.6	38
Target Ridge •Wallowa Valley	300	180	100	0	60	0
South Dooly Mtn. •Burn Project-Baker	5019	1005	4014	20.6	20	29
Horse Creek Blowdown •HCNRA	1225	788	437	20	60	4
More Bug Lodgepole •Wallowa Valley	190	75	115	0	39	0

Key to inventory data categories:

A: Total Acres
B: Acres Inventories
C: Acres Not Inventoried
D: Estimated Acres Within Site Boundaries
E: Intensity of Survey Sample (% of Coverage)
F: Number of Properties Identified

A PRACTICAL APPROACH TO CULTURAL RESOURCE INVENTORY IN A FORESTED ENVIRONMENT

Carl M. Davis
Deschutes National Forest

Abstract

The cultural resource inventory program on the Deschutes National Forest in central Oregon is conducted in accordance with an established Forest inventory plan. The plan is pragmatic and largely inductive in approach. One intent of the plan is to reduce the number of costly, project-level inventories in favor of more areally comprehensive, resource-oriented field surveys. The plan also attempts to partially resolve the nagging questions of site "visibility" and the thoroughness of area "clearance" in a forest environment by identifying cultural resource probability zones. These zones guide the field survey and highlight areas where resurveying and continuous monitoring are required. Once critically scrutinized and evaluated, these inventory data should provide reliable baseline information that can be used to develop site location predictive models and prehistoric settlement pattern studies for the Forest.

Legislation developed in the 1970's requiring federal agencies to inventory for prehistoric and historic sites has laid the groundwork for much of the archaeology currently practiced in the United States. The effectiveness of this inventory effort can be measured by the large amount of site and survey information on file in various State Historic Preservation Offices throughout the country. Though these data are extremely variable and remain largely untested as to accuracy and thoroughness, our understanding of the prehistoric record of many states and regions currently rests on the information compiled during federally mandated cultural resource inventory. These data are now being used to develop inductively and deductively based inventory plans and site location predictive models for many regions of the United States, including the Pacific Northwest (Cordell and Green 1984; Keyser 1983).

This paper discusses a cultural resource inventory plan developed for the Deschutes National Forest, an arid forest encompassing the High Lava Plains of central Oregon and a portion of the eastern flanks of the Cascade Range (Davis 1983). The paper describes the fundamentals of the plan, including its rationale, benefits and shortcomings.

Briefly, the Deschutes National Forest is an upland forest environment characterized by gentle topographic relief and the absence of well-developed drainage systems. It is composed of dry lodgepole and ponderosa pine forest, lava buttes and cinder cones, and pumaceous soils from various regional and local Holocene pumice and ashfalls. Though the forest encompasses a small part of the Deschutes River valley, the majority of the Forest is foothills and mountains which remain snowbound for at least six months of the year. The Forest's cultural resource inventory program is focused on the forested mountain slopes and buttes where some 40,000-50,000 acres or more are annually harvested [or silviculturally "treated" (thinned)] for timber.

The Deschutes National Forest inventory plan was developed for several reasons. First, cultural resource management is comparatively new to the Deschutes National Forest, effectively beginning in 1981. Very little information is available regarding cultural sites or the intensity of survey work that has been done in central Oregon. Generally, extant archaeological data are interpreted within very general culture-historical and typological frameworks (e.g. Minor et al. 1979; Toepel et al. 1981; Pettigrew 1982). Thus, some type of inductively based inventory plan was necessary to establish a basic inventory methodology and a set of standards and guidelines by which surveys could be designed and implemented.

The inventory plan introduces the use of broad-area survey designs by including land inside and outside the boundaries of particular ground-disturbing projects (Figure 12). From a resource-oriented perspective, nothing is more frustrating than surveying a specific project area, particularly a timber sale on forested mountain slope, with the knowledge that areas with higher potential lie immediately outside the project area. For example, a creek drainage at the base of a heavily timbered mountain slope may never be inventoried for cultural resources because of the lack of major ground-disturbing projects in the area. Thus, the inventory plan is a means to legitimately expand survey project boundaries to form viable sampling units which include both low and high potential

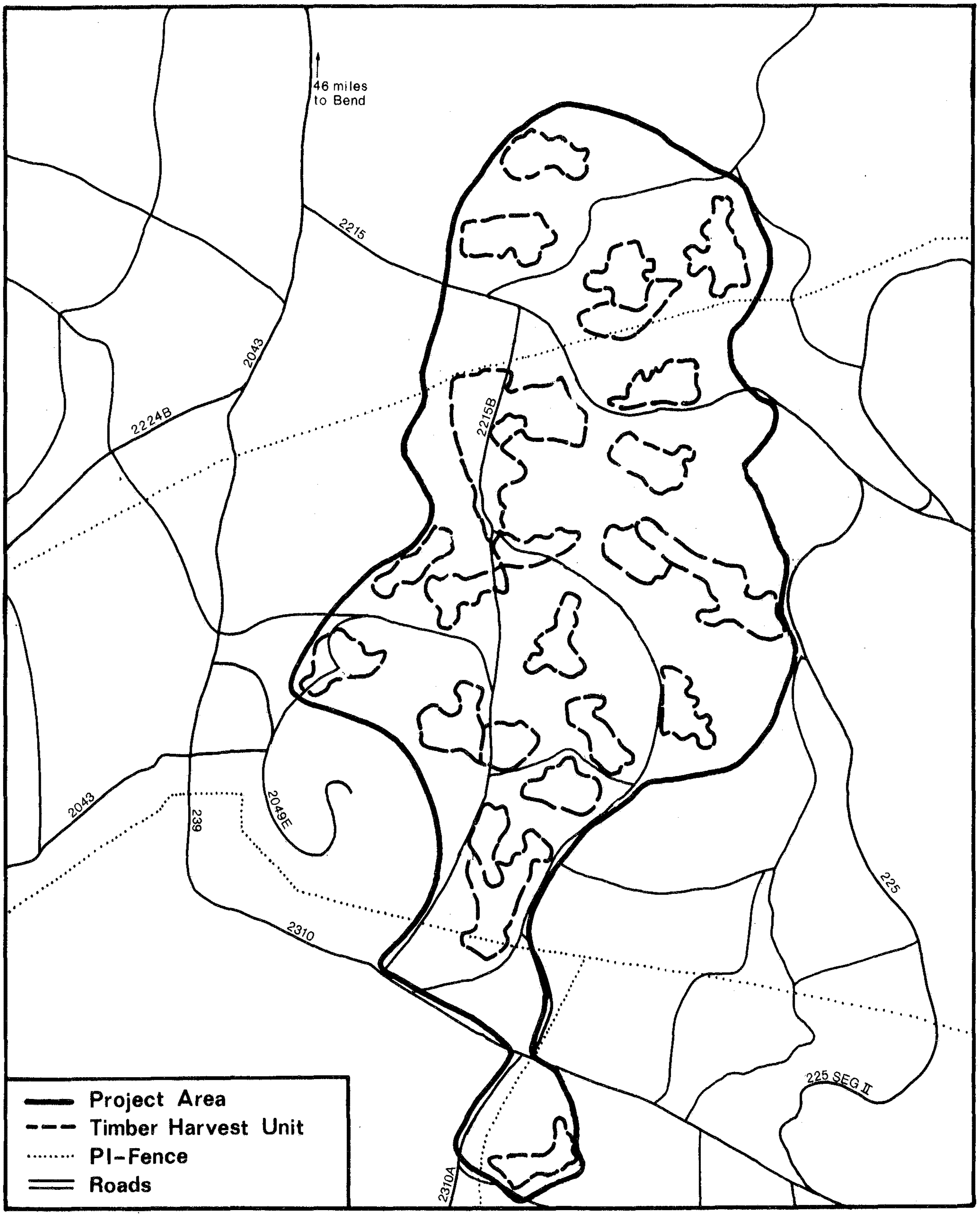

Figure 12: Typical example of timber harvest units in relationship to cultural resource inventory project area.

areas. This approach focuses on a complete and systematic cultural resource inventory of the forest rather than on project-level legal compliance.

An important benefit of a comprehensive resource inventory program is that cultural resources can be considered during short and long-term Forest planning rather than at the onset of specific ground-disturbing projects—which tends to provoke "crisis" management and decision making. In other words, the cultural inventory is done well ahead of project design and layout (e.g. timber cutting units, recreation facilities). This provides for a positive rather than a reactive approach to cultural resource management and integrates cultural resources into the procedures of the National Environmental Policy Act (NEPA) and the National Forest Management Act.

Finally, the plan delineates the Forest into cultural resource probability zones which, in terms of long range project planning, provides for additional inventory and careful monitoring in culturally sensitive areas. This recognition places cultural resources on equal footing with other Forest resources, such as wildlife, soils or timber, whose responsible management is also not based on the data gathered during a single inventory, nor on the somewhat archaic concept of "area clearance."

From the plan's inception, it was recognized that a complete, 100% intensive survey of the entire Forest was impossible. Thus, like other inventory plans in the Region (Reagan 1981; Marvin 1983), the plan is a sampling-based inventory design intended to locate as many sites as possible given the familiar constraints of archaeological inventory in a forested environment (e.g. pine needle duff cover, deadfall, steep terrain). The plan is intuitive in approach because it uses information gained from previous inventories to guide field searches. The intensity of the field search is weighted proportionally to a particular area's likelihood or probability of yielding cultural resource sites. Each successive survey is built on information derived from previous surveys, providing better, "more informed" predictive criteria. The intuitive basis of the design is counter-balanced by random sampling, particularly in areas demonstrated to be of moderate to low cultural resource potential (e.g. timbered mountain slope with 30 to 40% slope).

At present, the inventory plan is simple and straightforward. It is divided into three sequent phases, the first of which involves the development of a survey design for a particular ground-disturbing project. The project area usually includes the proposed impact area, as well as a representative sample of land adjacent to it, and is generally enlarged with reference to a particular geomorphic feature. For example, the survey of impact areas adjacent to a river might be expanded to cover adjacent areas of river frontage.

The project area is stratified, or divided, into site probability zones on the basis of its known cultural resource base and known or suspected environmental correlates. These include:

1. Presence of water;
2. Prominent geomorphic and topographic features, such as stream terraces, ridge systems and lava features;
3. Known cultural resource base;
4. Travel and transportation routes, especially Indian trails and military wagon roads through the extensive lava fields and mountain passes;
5. Condition of landscape, particularly the presence of timber clearcuts and harvest units, tree plantations and other disturbed areas;

These environmental and cultural correlates are marked on USGS quad maps and aerial photographs. The entire survey area is then divided according to where various features are clustered and where they are not. For example, a terrace system bordered by rock overhangs above an intermittent drainage could form one cluster; a large, densely covered, lodgepole pine flat containing a number of large clearcuts might demarcate another.

Once the project area is delineated into clusters of environmental and cultural features, each cluster is assigned to a cultural resource probability zone. Areas with four or more features present are high probability zones, those with three features comprise the medium zone, and those with one or no environmental/cultural features are included in the low probability zone. All of the area comprising the medium and high probability zones are surveyed during the field inventory. In order to ensure that a representative sample of the low probability zone is selected for survey in an unbiased manner, a random sampling procedure is used. If the low probability zone consists of a number of small-sized tracts or areas such as timber harvest units, a random sample of these are selected for survey. If the low probability zone is composed of only a few large areas, then these areas are divided into equal-sized units from which a random sample is chosen.

The second phase involves the field search. From 85% to 100% of the high probability zone is surveyed intensively using 10 to 30 meter transect intervals. From 45% to 60% of the medium probability zone is surveyed; in this zone, particular effort is placed on those features which characterize the area, such as a rock ledge overlooking a dry gully or a prominent ridge located in dense pine forest. Elsewhere, coverage is more widespread using transects spaced from 75 to 100 meters apart. From 5% to 15% of the low probability zone is surveyed according

to the random sampling scheme previously discussed. The areas selected in the random sample are surveyed intensively; the other low probability areas are spot checked or not examined at all.

Using this survey coverage, a total of approximately 30% to 60% of any given project area is intensively examined on the ground. During the field inventory, all survey transects and routes are marked on either topographic maps or aerial photographs and show the level of inventory coverage. It is worthwhile to add that any given project area receives additional coverage during the course of design and layout (such as timber harvest units), often by cultural resource technicians. Although this type of coverage is usually not formally acknowledged in Forest survey reports, it does provide a measure of security against inadvertent destruction of cultural resources not found during formal inventory.

The final phase includes the formal inventory documentation and project area monitoring.

This inventory plan has been used for three field seasons from 1982 through 1984. During this time, a total of 64 major project surveys were undertaken using broad-area inventory designs. These 64 projects encompass a combined total of 250,000 acres which represents the total area inventoried and "cleared" as a result of the surveys. The majority of these areas are characterized by steep forested mountain slope and dry, gently rolling pine forest. Out of this total, 108,000 acres (43%) comprise the amount of land sampled or actually surveyed. Of this acreage, 43,000 acres, 37,000 acres, and 28,000 acres were surveyed in the high, medium and low probability zones, respectively (Table 11).

Some 293 historic and prehistoric sites were located during these inventories. 192 sites were found in the high probability zone, 49 in the medium probability zone and 52 in the low probability zone. As a comparative measure, the high probability zone yielded one site per 223 acres surveyed; the medium zone yielded one site per 755 acres surveyed; and the low zone yielded one site per 538 acres. Qualitatively, there is little difference among the sites found in each zone; generally, they comprise large and small lithic scatters and railroad logging sites. Historically, railroad logging and intensive timber harvesting have disturbed to some extent most of the cultural sites located during these inventories.

The results of three years of inventory show that the inventory plan successfully focuses on the high site probability areas, particularly for prehistoric sites; it simply highlights the obvious criteria and logic that all archaeologists apply as a practical matter when surveying. However, historic sites have been more difficult to predict for in all probability zones, apparently because their locations are determined by an industrial rather than an environmentally-based technology. The medium and low probability zones cannot be differentiated, as indicated by the close number of prehistoric and historical sites each zone yielded, but given the simple and rather generic nature of the plan's current criteria and structure, these results are hardly surprising.

In an effort to address this sampling problem ("the largest number of sites will be found where the greatest effort is spent looking for them"), the survey designs on two Ranger Districts were altered during the 1984 field season (Steece 1984; Youngs 1984). The high probability zone in each project area was selected according to the Forest inventory plan. The remaining area was designated as low probability and a random sample (20% to 30%) of each project area was selected for survey. A medium probability zone was not delineated. The sample units were examined intensively using flagged transects located 15 to 30 meters apart. When the high probability zone and the random sample were combined, each project area was given approximately the same amount of total coverage (about 40%) as those surveyed during previous field seasons.

Surprisingly, only four sites, and a number of isolated finds, were found during the nine project surveys, which intensively covered approximately 16,000 acres out of a total of nearly 29,000 acres. The random sampling strategy appears to partially support the current inventory plan but most of the project areas were of low probability for cultural sites—that is, large tracts of waterless pine forest with little topographic relief or geomorphic variability intermixed with steep buttes and mountain slopes which remain snowbound for much of the year. Thus, more extensive random sampling and survey in the low and medium probability zones are necessary before these zones can be actually differentiated.

The situation described above emphasizes the need for flexible inventory planning. The Forest plan will undoubtedly undergo further modification and change as more data accumulates. At present, the plan's shortcomings relate to the size and adequacy of the inventory sample and how this should be constructed.

In a larger perspective, these problems are fundamental to all inventory plans and predictive models (e.g. Mueller 1975; Lovis 1976), and are a reflection of the complex and multifaceted scientific and legal issues surrounding resource inventory (cf. King 1983). On one hand, an inventory is expected to yield scientifically useful information and a "representative" sample of the resource and archaeological record. On the other hand, an inventory should meet "legal compliance" and is expected to be

Table 11: Inventory results: 1981 – 1983 field seasons*

Probability Zone	Acres Surveyed	Sites Located
High	43,000	192
Medium	37,000	49
Low	28,000	52
Total	108,000	293**

*These results cover a total of 64 major timber sale project inventories in the Cascade and Paulina Mountains. Total project acreage was 250,000, including substantial areas of steep (over 30%) slope.

**The site total includes both prehistoric and historic cultural resources found during timber sale inventories; it excludes isolated finds.

"cost-effective." In essence, inventory serves a wide constituency and multiple agendas, and the concept of "inventory" remains in many ways as ambiguous and problematic as defining sites and site "significance" in archaeology and cultural resource management. Thus, for purposes of this workshop, it is worthwhile to briefly highlight some of the basic questions which stemmed from the development of the Deschutes Forest's inventory plan:

1. How can a Forest's cultural resource inventory program be legitimately integrated into Forest Service multiple resource management? Should inventory be primarily initiated by ground-disturbing projects (since project support dollars [timber] largely fund inventory) or can the inventory program be expanded to cover more area, thus providing cultural resource data for long range forest and project planning, and the environmental review (NEPA) process? Given limited budgets, time and personnel constraints, the latter approach requires some type of archaeological sampling to cover larger areas which contrasts with the traditional project-specific cultural resource inventory on Forest lands. This places the emphasis less on compliance-level "policing" and more on compliance-level planning. Is this legitimate?

2. How is the term "legal compliance" to be defined for broad-area cultural resource inventory? In the Deschutes Forest inventory plan, legal compliance is met when the survey "sample includes 100% coverage of the high probability areas" (Davis 1983:8). This is supported by the Advisory Council on Historic Preservation (King 1978:92-94) but is obviously open to interpretation. The appropriate level of project inventory coverage appears to vary greatly among contractor, academic and agency survey reports for central Oregon (e.g. Toepel and Beckham 1982; Russo-Card 1982; Steece 1984; Lyman et al. 1984), even though the documents all ostensibly fulfill legal compliance for the agency and purpose for which the project was undertaken. In essence, what constitutes an appropriate level of survey coverage or area sampling, regardless of resource probability or institution, agency or individual conducting the survey?

3. How can the survey area itself be realistically stratified and sampled to yield a "representative" distribution of an extremely varied and enigmatic phenomena called cultural resources and "scientific data?" Can upland forested environments, which remain snowbound for three-fourths of the year, be expected to yield a representative sample of the resource and "rare" sites? Can one inventory plan or predictive model be used for all types of resources through time or do they really only address a very small part of the record or resource? How realistic are our scientific and managerial expectations of an inventory plan or predictive model?

4. Finally, can the complicated issues of site "visibility" (or "discoverability"), and sampling be adequately controlled for within the bounds of legal compliance surveys? Should a single, project compliance initiated survey, particularly in an environment covered with thick duff and vegetation constitute area "clearance?" How can the results of previous resource inventories and field data (and thus, archaeological or historical interpretations and explanations of the project results) be empirically tested and evaluated (and the resource itself realistically safeguarded) without the legitimate opportunity to resurvey the same areas over again?

Inventory planning cannot possibly resolve all of these problems but it does serve to bring many of them to the forefront. Inventory planning provides a logical link between traditional project-level, compliance-oriented survey and deductively-based predictive modeling because it focuses on the problems and ambiguities of the field search and field data themselves. Other forest resources, such as timber, wildlife and soils, have their own body of method and theory relating to inventory and field sampling which form the basis of long range planning and research (e.g., predicting future timber harvest volume, carrying capacity and biomass potential, fuels loading). Inventory planning provides an opportunity to develop a comparable body of inventory concepts (e.g. site discoverability, transformation processes) and methods (e.g., subsurface sampling and site location techniques, survey design techniques) which will only enhance the profession's ability to both explain and manage cultural resources. These data should then form a viable and empirically tested set of information about sites and their locations on which predictive models and settlement pattern studies can ultimately be based.

BOUNDARIES OF PREDICTION IN THE GIFFORD PINCHOT NATIONAL FOREST

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Abstract

The cultural processes determining site locating behavior for the high country of the southwest Washington Cascade Mountains are not entirely understood. Thus, archaeological and historic site distributions, known in sampled areas of western Washington and Oregon, were used to predict attributes of unsampled areas of the Gifford Pinchot National Forest. A univariate model using data from approximately 500 sites was developed to select areas with high, moderate, and low potential for the location of cultural resources. Testing of the predictive model occurred during the field seasons of 1983 and 1984. Due to differences between the northern and southern regions of the Forest, it was determined that different models would be required for each region.

Like all Federal agencies, the Forest Service is required to inventory and manage the cultural environment on those lands which it administers. In general, the particular objectives of any cultural resource management program are bounded by an existing body of Federal laws and regulations. However, the specific manner in which any particular agency implements these objectives varies within its organizational structure and broader agency mandates.

Unlike the vast majority of land-based resources on National Forest lands, cultural resources are nonrenewable. Thus, multiple use management, to strike the necessary balance, requires a cultural resource process of informed decision-making in order to make the best use of money, personpower, time, and the resource itself. Given that responsible decision-making cannot occur in an informational vacuum, the single most important requirement in this decision-making process is information: a knowledge of the location, nature, extent, and significance of those cultural resources within the Forest's domain.

The Gifford Pinchot National Forest comprises approximately one and one half million acres of public land in southwest Washington. It extends from Mt. Rainier National Park on the north to the Columbia River on the south, and from Mt. Adams on the east to Mount St. Helens on the west. The area is characterized by ridge crests separating steep, deeply dissected valleys and an extensive gently sloping plateau around Mt. Adams containing small lakes and sub-alpine meadows. There is an altitudinal difference of more than 12,000 feet between the highest and lowest points on the Forest. Over three-fourths of the Forest contains some degree of volcanic ejecta, primarily pumice and ash, from pre-1980 volcanic eruptions (Snyder and Meyer 1971). Pumice, ash, and debris cover resulting from the 1980 and subsequent eruptions of Mount St. Helens range from negligible to a depth of approximately 600 feet.

The Gifford Pinchot, while a multiple-use Forest, is primarily organized for timber production and harvest. The annual timber sell level is the highest of any National Forest in Washington State and the second highest in the nation. The Cultural Resource Management inventory program is project driven and funded. Current emphasis on the Gifford Pinchot is directed toward the timber program and recreation impacts in the much-visited Mount St. Helens National Volcanic Monument. Representative of the inventory program, 81% of the surveys conducted in FY 1983 were in support of timber management, accounting for 97% of all acreage inventoried that year. Slightly less than 5% of the total Forest land-base has been inventoried for cultural resources.

The Gifford Pinchot National Forest hired their first archaeologist in the field season of 1980, following the discovery of a lava tube cave containing pestles, mortars, and rock wall alignments. At that time archaeological investigations in the southwestern and central-western portions of the state, and indeed throughout much of the entire Pacific Northwest, had been focused on one particular microenvironment. Most surveys, and thus most located sites, were restricted to the floodplains of the area's major rivers. And, even in that region which had enjoyed by far the greatest field appraisal, the Columbia Plateau, the understanding of cultural dynamics was predominantly based on that limited portion of the settlement/subsistence system contained within the alluvial floodplains. This former bias resulted in little extant information about prehistoric utilization of the area encompassing, and immediately adjacent to, the Gifford Pinchot National Forest.

Reconnaissance within the Forest prior to 1980 had recorded little in the way of evidence of previous human use. In addition to the overview information resulting solely from a literature search, less than 5 site forms for prehistoric sites and only a few more than 100 site forms

for historic sites were on file. The bulk of the inventories had been conducted by cultural resource technicians, and many of the site forms had been generated through literature searches involving no field verification. The Forest previously had contracted archaeological inventories to local universities and consulting firms. Though the contract archaeologists did locate sites, neither Forest Service nor state site forms were filled out by most contractors. Therefore, information that should have resulted from these field investigations, and thus appeared on site forms, such as percent of slope, aspect, distance to water, elevation, and local environmental characteristics, was missing. In addition, the more than 100 historic site forms were confined to one geographic area, the result of one interested person's efforts, and did not represent Forest-wide coverage. The effort was, nonetheless, a blessing; an erupting volcano was to significantly alter that landscape and most of those historic site locations.

Three field seasons of professional archaeological inventories were conducted on lands administered by the Gifford Pinchot National Forest, primarily in support of the timber program. Not far in front of the tractor and yarder, surveys concentrated on those areas proposed for ground disturbance, mainly timber harvest units including a 200 foot buffer. Inventories used both intuitive and probabilistic strategies, and varied based upon environmental conditions. Topographic maps and aerial photos were used to identify potential areas of use and areas of enhanced surface visibility. Literature searches and informant interviews also helped define zones of possible site location. Once in the field, survey was also directed at areas where previous ground disturbance and environmental conditions yielded surface or subsurface exposures. Both intensive transects with 10 to 25 meter spacing and opportunistic investigations were used, depending on local conditions. The latter of these methods was employed particularly where blowdown timber resulted from windstorms and the volcano. Shovel testing was conducted as deemed necessary by the District or Forest Archaeologist. Reports were written for all inventories, averaging close to 100 per year. Those that located cultural resources were forwarded, as per Memorandum of Understanding, to the State Historic Preservation Officer for consultation and review.

Two situations that plague archaeologists working in the National Forests to greater or lesser degrees, depending on location, are worth discussion. The first of these related to which areas receive survey at all. Much to the amusement of local informants who want to know why you are looking *THERE,* cultural resource inventories are conducted where projects are planned. An archaeological inventory built primarily through examination of areas affected by modern human activity will clearly be biased in favor of those locations where the activities in question occur. However, timber harvesting in particular is practiced on most kinds of terrain, at most elevations where trees regenerate, and in most environmental zones. It has been suggested by Aikens (1976), that although this does not provide for a truly statistically random sample, most terrain types do receive examination. In those areas where merchantable timber is scarce, resource location depends on projects such as trails or upon archaeologists with spare time. The other concern is visibility. Undisturbed timbered tracts have been known to conceal not only archaeological sites, but historic sites as well. One would think all previous human land use on the west side of the Cascades occurred in roads, firelines, timber sale units, and the like. Following pre-project inventories, post-project monitoring is often done where likelihood of resources being located is high to verify inventory results. Visibility was further hampered in the Gifford Pinchot National Forest with eruptions of Mount St. Helens. In that case, even game trails, clear-cuts, and roads proved useless for site location—much like doing archaeological inventories in snow. Beyond investigations for eruption related artifacts, surveys in ash covered areas of the Forest are primarily done during and after project ground disturbance.

Additionally, much of the National Forest system lands in the Pacific Northwest tend to be high elevation, steep, heavily timbered mountains. In many areas, lands favored by homesteaders and likely by prehistoric inhabitants, have been removed from Federal management. Thus, we must rely on the archaeological community for these data. On the other hand, surveys of high elevation mountainous terrain were rare until the mid-1970's. The Forest Service Cultural Resource Management program then will potentially provide the archaeological community with much needed information to balance the historic bias toward floodplains and major rivers.

The final objective of a predictive model might be to provide data on the nature, diversity, distribution, and significance of cultural resources in the defined study area. The initial effort, however, must be directed at identifying how locales where sites occur differ from those where they are not found. An assumption is made that prehistoric sites and, possibly to a lesser degree, historic sites are correlated with environmental attributes rather than being randomly scattered across the landscape.

Both univariate and multivariate predictive models can involve multiple environmental variables (Klesert 1983). For problems of predicting relative site patterns and densities over broad, regional areas, a univariate model is preferred (see Plog and Hill 1971 and Plog 1981 as cited in Klesert 1983). When approaching the more precise problems of predicting exact, pinpointed locations of

sites, a multivariate model is applied (Chandler and Nickens 1983; see also Kvamme 1980 and Larralde and Chandler 1981 as cited in Klesert 1983). With a regional prediction regarding relative areas of site potential the desired outcome, a univariate model was selected using multiple environmental variables. Further, as noted by Klesert (1983), a requisite step for moving to finer levels of resolution, such as those produced by multivariate models, is a univariate compilation of data.

Once the appropriate model type has been determined, those variables that would be selected for, or would constrain, historic and prehistoric use of the local environment need to be derived. Archaeological and historic site distributions, known in sampled areas of western Washington and Oregon, were used to predict attributes of unsampled areas of the Gifford Pinchot National Forest. The Forest inventory effort, in combination with information from seven surveys outside the Gifford Pinchot and west of the Cascades in Oregon and Washington (Jones et al. 1978; Ayers et al. 1979; Blukis Onat and Hollenbeck 1980; Hollenbeck and Hollenbeck 1980; Beckham et al. 1981; Hedlund 1981; Welch n.d.), provided a data base of approximately 500 prehistoric and historic sites with which to work. Microenvironmental characteristics of sites located on the Forest such as peeled cedar; mining claims; rockshelter, cave, and lava tube sites; and talus slope features were discussed. A total of 22 environmental variables were distilled by the five archaeologists then working on the Forest. It is worth noting here that peeled cedar sites on the Forest have been dated to both the historic and prehistoric time periods. Since most stands of these trees remain undated, and ethnohistoric information strongly suggests Native American origins, the prehistoric age classification refers in this context to prehistoric and aboriginal sites. Of the 567 sites used to determine environmental attributes for this study, 54% were classified as prehistoric.

The number of historic and prehistoric sites occuring within each of these environmental zones was tabulated by Ranger District and then combined to obtain Forest totals. Categories were not mutually exclusive. For example, a given site might occur at a spring in a saddle, and would therefore be tabulated under each. Again, the desired objective is predicting areas of site potential, rather than exact site locations. Percentages were developed for frequency of site occurrence in relation to each attribute, although in some cases, data on site forms were incomplete, inadequate, or missing altogether. For example, half of the historic and prehistoric site forms had no elevations recorded. The extent to which each attribute exists within the Forest, and therefore the extent to which it was available for human use, was not determined. Thus, while the results were not truly comparable, it was a larger body of information than had ever been assembled for the high country of the southwest Washington Cascades. So, upward and onward.

Analysis of the known cultural resource data base for the Gifford Pinchot National Forest provided several significant correlations with environmental variables: distance from water, percent of slope, and geomorphic/topographic features. Both historic (76%) and prehistoric (69%) sites are predominantly located within 100 meters of a current water source. Features such as river terraces, springs, and lakeshores were included in this classification while marsh/meadow/swamp environments were not. As stated previously, field surveys contributing information to this study were primarily conducted on impact areas and their buffers. Consequently, features such as floodplains and springs are less well represented in study results.

Slopes of 20% or less contain 85.6% of the prehistoric resources and 55.1% of the historic resources on the Forest. In addition to percent of slope, elevation, aspect, and direction of slope were studied. Due to inconsistencies in the amounts of information available for each site, it remains unknown whether direction of slope, elevation, and aspect are relevant variables for predicting site occurrence.

Those geomorphic/topographic features that demonstrated the strongest correlation with prehistoric site locations are ridge lines, bases of slopes, mid-slopes, and marsh/meadow/swamp environments. Peeled cedar, and cedar in general, are largely located in the latter and in mid-slope drainages. Remains of historic land use are primarily found at the base of slopes, on mid-slopes, and on ridge peaks. Historic trails account for much of the mid-slope activity, and fire lookouts were abundant on ridge peaks in Forests with steep, deeply dissected drainages, such as the Gifford Pinchot. Historic sites are also frequently found in openings in the timber and areas where the canopy is sparse. These openings are not necessarily natural, but in many cases have tended to resist regeneration due to highly compacted soils. Historic sites located in such zones include camps related to logging, grazing, and the Civilian Conservation Corps.

In summary, areas within 100 meters of a current water source; slopes of 20% or less; and ridge lines, midslopes, bases of slopes and marsh/meadow swamp environments have a high correlation with prehistoric site locations Forest-wide on the Gifford Pinchot.. Historic evidence of previous human land use across the forest is most likely to be found within 100 meters of water, on slopes of 20% or less, and at the base of slopes, in midslope, on ridge peaks, and where the tree canopy is open or sparse.

Of the three major probabilistic sample types (Marvin 1982), one that used prior knowledge of the defined study area is appropriate. Thus, a stratified sampling strategy was selected. Known or suspected environmental attributes plus prefield research provide the basis for stratifying each project survey area into site location probability zones. These stratifications are determined by the presence or absence of any single environmental attribute exhibiting a correlation with cultural resource sites. Site location zones are delineated High, Moderate, and Low Probability. Percent of coverage varies within each. Field investigation is intended to incorporate use of aerial photos and opportunistic strategies due to the problem of visibility restrictions in densely forested environments.

During the field seasons of 1983 and 1984, the model for where to look on the Forest and how intensively to look once you get there, was to be tested. Since prehistoric sites are harder to find where ground disturbance has not already occurred than are historic sites, a plan to test the positive environmental and cultural correlates derived for prehistoric sites was developed. Site location probability zones were stratified by degree of correlation between environmental variables examined for this study; those associated with 10% or more of the extant prehistoric resources on the Forest were judged High Probability. Distance from a current water source and percent of slope demonstrated clear relationships with known prehistoric site locations across the Forest. Two geomorphic/topographic featues, marsh/meadow/swamp environments (12.6%) and midslope sites (18.4%), met these criteria. The latter was arbitrarily placed in the Moderate Probability Zone. Other geomorphic/topographic features where sites occurred in frequencies of less than 10% Forestwide, were designated Moderate Probability.

Environmental variables within the High Probability sample zone included areas within 100 meters of a current water source, slopes of 20% or less, and marsh/meadow/swamp environments. Pre-field research added information from the known cultural resource data base, local informants, and the literature search. These data on known or potential site locations were considered indicative of a High Probability for locating cultural resource sites. The High Probabilty sample strata received 100% coverage. As defined by Connolly and Baxter (1980), 100% coverage consists of transects no further than 50 meters apart and is combined with subsurface shovel testing when necessary.

Areas of Moderate Probability were characterized by slopes of 20-30% and were more than 100 meters from a current water source. Specific geomorphic/topographic features in this probability zone were bases of slopes, lava tube areas, openings in the timber, slope benches, talus slopes, midslopes, cliff faces, saddles, and ridge lines. Survey in this zone varied from 40-60% coverage. Since many of these strata with moderate potential for site location are linear features, properly selected transects of approximately 75 meters distance were judged to be effective in locating sites by Connolly and Baxter (1980).

Low Probability zones are those areas where ground slope is greater than 30%. Most often included are mountainous areas. Transects across slopes in this zone can locate previously unknown historic trails and peeled cedar. Greater than the recommended coverage can often be achieved by using these areas as routes between High and Moderate Probability zones. Coverage of 10-20% was considered appropriate.

In testing the plan outlined above during the field seasons of 1983 and 1984, it became apparent that the model was not sensitive enough with respect to local geomorphic/topographic features. This was particularly true on the south half of the Forest. Archaeologists conducting inventories and supervising cultural resource technicians within the south portion of the Gifford Pinchot noted almost immediately, in using intuitive surveys to supplement the sampling plan, that they found as many or more sites in Moderate Potential as in High Potential zones. Since lag time between cultural resource inventories, sale of the timber, and purchaser harvest often totals eight years or more, post-project monitoring was not available on most large projects to further verify inventory results. However, several differences in prehistoric use patterns across the Forest, as evidenced by the positive environmental and cultural correlates, are clear. While sites rarely occur on the north part of the Forest in such locations as saddles, midslopes, lava tube areas, and marsh/meadow/swamp environments, these are areas on the south part of the Forest where sites are likely to be found. Similarly, as noted in the following table, sites are frequently found in locations on the north half of the Forest while being found there rarely or not at all in the southern region.

Elevation and direction of slope are not included here, as data are sketchy. In comparisons between the northern and southern halves of the Forest given above, the area around Mount St. Helens was not included. Data are largely missing or inadequate for that purpose. The information is included in Forest totals.

In conclusion, the plan developed for prehistoric site location zones served as a beginning and a learning process. Revisions are needed Forest-wide for greater sensitivity to local environmental features. In addition, the possibility of this or any model being a "self-fulfilling prophecy" of the model builder requires attention. Following revisions, such as determining to what extent environmental attributes are available in the Forest to be

exploited by humans, a next step will be to add historic site location information to the model.

Some very real differences were demonstrated between the northern and southern halves of the Forest that bear looking at more closely. Based upon even the most cursory examination of a topographic map, it is apparent that rivers and creeks drain in an east-west orientation on the northern half of the Forest and drain north-south on the southern portion. Cultural affiliations with lands administered by the Gifford Pinchot has been disputed (Jermann and Mason 1976); however, it is entirely probable that differences discussed in this study between the north and south parts of the Forest relate to different cultural user groups: the Coast Salish in the north, Sahaptin speakers from the Columbia Plateau in the mideastern part of the Forest, and the Chinookan groups from the Columbia River in the south. Finally, it is hoped that regional refinement of predictive models will provide insight into the settlement/subsistence systems in high elevation Cascade Mountain environments.

CRISIS MANAGEMENT: A CULTURAL RESOURCE SURVEY CHALLENGE

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Abstract

Recently, an unusual emergency situation on the Colville National Forest in northeastern Washington necessitated preparing numerous timber sales in an area of approximately 110,000 acres on the southern half of the Kettle Falls Ranger District. These sales were planned quickly and the trees harvested within one to two years to lessen or avoid destruction by the mountain pine beetle. Our normal cultural resource survey strategy involving 20-30% coverage of individual sale areas would have been cumbersome given the number of sales and the short time frame. The solution was a survey strategy that was, in fact, more sensitive to the cultural resources because we designed it to locate potential resources over the entire 110,000 acres, rather than adhering to individual timber sale boundaries.

Introduction

Crisis management is a cold reality in federal land management and often it is unavoidable. We usually anticipate it with dread, criticize it with fervor, and assume it spells doom for many of the natural and cultural resources. Our challenge as cultural resource managers is to accept crisis management when it is indeed unavoidable, and try our best to mold it to the advantage of the resource. A recent crisis on the Colville National Forest necessitated a cultural resource inventory of approximately 110,000 acres. Given the vast area involved, the only reasonable approach was to try and predict where the resources would be and field verify those resources. As many have pointed out, there is a real danger in substituting a predictive model for an adequate clearance project. Our solution was a combination of a predictive survey strategy, field verification, and monitoring.

Project Background

The cause of this particular crisis goes back to 1929. During that year, a devastating forest fire burned hundreds of thousands of acres of forest and private land between the Kettle Crest and the Columbia River. The Dollar Mountain Fire virtually stripped this area of vegetation, leaving only a few small pockets of timber and some isolated, fire resistant ponderosa pine. Natural regeneration of the area has resulted in stands of lodgepole pine which are highly susceptible to infestation by the mountain pine beetle *(Dendroctonus ponderosae)*. In the last few years, the infestation has reached critical proportions. Because the beetle can attack and destroy a stand in one season, the crisis for the timber managers is the need to sell and cut the timber quickly, without the normal lead time of six to seven years. For the cultural resource manager, the crisis is the need to carry out compliance inventory on 110,000 acres of densely forested land with very little access and virtually no ground visibility, in one field season. We could not even restrict the survey to potentially disturbed areas, because the timber managers did not know where the sales where going to be. The challenge seemed insurmountable.

When the district first came to me with their crisis and requested that I do a large scale clearance project and inventory all 110,000 acres, my initial reaction was to throw up my hands and say this was impossible! Normally, we survey timber sales well in advance of the actual harvest, thus allowing time for mitigation, testing, or more intensive survey if necessary, and we inventory approximately 20-30% of the gross sale area. Since the Colville National Forest plans approximately 50,000 acres per year in timber sales, this amounts to actual survey of approximately 10,000 acres per year on the whole forest or 2,000 on each district. In order to clear 110,000 acres using our normal strategy, they were asking me to cover 22,000 acres on one district in one field season—impossible! Faced with the inevitable, however, I began to look at the problem from the standpoint of the cultural resources, and I began to see some potential for benefit to the resource: I would not be restricted to arbitrary timber sale boundaries, I could inventory and record sites that may not lie within disturbed areas, and I could require monitoring of sensitive areas during and after harvest.

The Survey Strategy

The resulting plan is one which some have chosen to call a type of predictive model. I prefer to call it a survey strategy, as it does not fit the Secretary of Interior's definition which states that "predictive modeling is an application of basic sampling techniques that projects or extrapolates the number, classes and frequencies of properties in unsurveyed areas based on those found in surveyed areas." The strategy is similar to a predictive model in that it cannot be said to locate every site in a given area. It was developed in response to crisis, meets the needs of the agency, and benefits the management of the cultural resources—all timely goals, since in the federal government we are called upon more and more to do larger surveys in less time and with fewer dollars.

The strategy consisted of three main components. The first was an extensive literature search to identify all previously recorded sites, as well as sites alluded to in various publications, documents, and Forest Service records. This search also involved a study of aerial photographs, soil surveys, and vegetative habitat descriptions to reveal areas conducive to human use or habitation. The second component was a very straightforward survey strategy: inventory all sites indicated in the literature search and all areas deemed to have high potential for location of archaeological sites, based on geomorphological features, regardless of whether these sites or areas lie within proposed sale boundaries.

These two components together may be a sort of rudimentary predictive model, or at least the initial data base or sample from which to generate a predictive model. To consider these two components as a clearance inventory would be folly for several reasons. First, the total area covered in an inventory of known or suspected sites would probably be about 5% of the total project area. This can hardly be considered a reliable sample size. Second, archaeological sites have received only cursory consideration at this point, consisting of predictions for site location based on geomorphological features in the project area. To avoid possible oversight of resources within sale areas, I included a third component—a monitoring plan. This monitoring plan itself has two parts. First, after the boundaries of each sale are determined, the Cultural Resource Technician will submit a brief report describing the specific environment and recording any resource not identified in the initial report. This will insure that each area of actual ground disturbance will be scrutinized for cultural resources even if it was not included in the initial inventory of known or suspected sites. Secondly, during or after logging operations, when more ground is exposed, the Forest Archaeologist will test any sale area not surveyed in the initial inventory because of dense ground cover, but deemed to have high potential for archaeological site occurrence. This testing requirement will remain in effect for all subsequent ground disturbing activities in this area, even beyond the scope of the current crisis situation.

The first two components of the project, the literature search and the inventory, are the subjects of the initial report just submitted to the State Historic Preservation Officer. Given the extensive monitoring requirement, I felt comfortable in submitting this as a clearance project. In fact, we will be doing more monitoring in this area than we have anywhere on the Forest. The reason for this is that normally management chooses to avoid disturbing an area where archaeological testing is recommended. In this case, they do not have the option of avoiding an area; if the pine beetle is there, they must log the trees. Therefore, in order to meet the requirements for cultural resource clearance stated in this strategy, they must monitor any sale area deemed by the archaeologist to have any potential at all for location of archaeological sites.

The Results

The research involved in the literature search was easy because we know a lot about this region historically. The main historic activities affecting the Sherman Creek area were Native American travel to and from the salmon fishing grounds at Kettle Falls on the Columbia River, Hudson's Bay Company trapping, travel to and from the gold mines in Republic, logging, and finally the activities of the federal land management era. Of the twenty two sites predicted in the literature search, we were able to locate seventeen, representing all of the activities mentioned above.

The identification of sensitive areas for human use or habitation was not so successful. We identified one area on the basis of David Chance's work along the Columbia. Chance had recorded a campsite at the mouth of Nancy Creek, so the Nancy Creek drainage in the project area was listed as a sensitive area. Upon surveying the drainage, however, we discovered that it was not a conducive environment to human use, nor did we find any indication of use. Other areas recommended for survey on the basis of geomorphological features were so inaccessible or so densely forested that surveying them would have required costly ground clearing. Also, none of these areas were within the first round of planned sales and so were not in imminent danger. Given the crisis situation, the district had neither the time nor the money to carry out the testing. Identification of further sensitive areas is, at this point, dependent upon the sale area monitoring. I

will look at as many sales as possible as they are laid out and hope to identify areas in each sale that have at least some potential for location of archaeological evidence based on geomorphological features. Those areas will then be tested either prior to disturbance, if the ground cover will allow, or during and after harvest.

The advantage of this project to the timber managers was basically one of time savings. Even though they still must submit a monitoring report for each sale, this is not a full scale cultural resource reconnaissance report, and if no additional sites are located it will not require the 30 day consultation period with the State Historic Preservation Officer. The advantages to the cultural resource program were many. We were able to survey a large contiguous tract of land without restricting ourselves to project areas. We were able to complete the survey and evaluation of a linear feature which had been on hold for a long time because only small segments within various projects had been surveyed. Most sites inventoried were known sites which never would have been recorded otherwise because they do not lie within project areas. Finally, we will have the opportunity to test many different types of environments for archaeological sites, and hopefully to increase the data base for the forest. Perhaps the most important advantage was a more indirect one: we were able to show that cultural resource managers can be cooperative and sensitive to the needs of other resources. Hopefully, as a result of this managers will give us more opportunity for innovative survey methods that will indeed benefit the cultural resources.

Conclusions

Given the wealth of records and historic documents we have covering Forest Service lands, there is probably no better, or at least more practical survey strategy for historic sites than an intensive, thorough literature search. Through study of a combination of General Land Office Survey plats (many of which stem from the mid to late 1800's and so may also contain valuable ethnographic clues), old Forest Service maps dating back to 1905, homestead patent records, mining patent records, local community histories, and interviews with old timers, we should be able to glean a fairly comprehensive picture of what we're likely to find and where to look for it. As long as these kinds of records are available, I think this is the most practical way to approach a survey area known to have historical sites.

The obvious weak point in this project was the lack of a predictive strategy for [prehistoric] archaeological sites. Very few prehistoric sites have been discovered in the forested highlands of northeastern Washington. There are probably many reasons for this. First, the kinds of activities taking place in the forested areas prior to contact were seasonal subsistence activities such as hunting, trapping, berry picking, and travel between the Columbia and San Poil drainages. These activities by their very nature leave small, scattered, and isolated evidence. Secondly, what evidence there is lies under a thick layer of vegetation and debris. Finally, and perhaps most importantly, the archaeological research done in northeast Washington to date displays a bias towards riverine surveys. I'd hate to admit that the only reason we haven't found sites is because we haven't looked, but this *may* be the case. Until we have a reasonable sample population, I would find it difficult to produce a very reliable predictive model. In the meantime, the only method I have found is using common sense, and if you will, an intuitive model. That has been to assume that benches, river terraces, areas surrounding a spring, meadows, mountain ridges, and stream confluences are pretty good places to look for an archaeological site. Hopefully, the monitoring required in this project will not only guard against disturbing sites, but will also provide the forest with a larger data base from which we can develop a reliable predictive model to replace or enhance our present intuitive model for archaeological resources.

Reflections

Many national forests share the Colville's situation with regard to cultural resources, i.e., a wealth of information and documentation of historic sites, and a serious dearth of information about prehistoric sites in the forested highlands. An extensive literature and documents search seems the most expedient way to predict the locations of historic sites. Given the lack of an adequate sample of archaeological sites, a predictive model is not yet possible. The problem becomes not the formulation of the model but rather the gathering of enough site information to form a sample population. The U.S. Forest Service, particularly in the face of current budget restraints, will not likely fund research projects to locate and record archaeological sites if those projects do not directly support current federal undertakings. In other words, if we want to develop an archaeological resource base so that predictive modeling may be possible in the future, we must think of a way to do it using current undertakings. Perhaps more monitoring of disturbed areas in current projects is a way to get that information without inflicting more cost to the agency.

Finally, even though this particular project did not involve a predictive model *per se,* it did involve a survey strategy, which like a predictive model does not necessarily locate all sites or structures which may be eligible for

the National Register. Neither a predictive model nor such a survey project, even with field verification, should suffice as a clearance project. Perhaps, however, in a crisis situation requiring large scale surveys, a predictive model plus field verification, accompanied by an extensive monitoring plan, could satisfy the compliance requirements. It may not always be the answer, but in the face of current budget restraints and the pressure we are under to do more with less and streamline our surveys, it may be worth a thought.

COMMENT ON FOREST SERVICE INVENTORY AND PREDICTIVE MODELING

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Abstract

Review comments are offered on the nature of Forest Service survey inventory and predictive modeling. Focus is given to Section 106, Section 110, and the role of predictive modeling. Recommendations are offered on the possible future direction of Forest Service cultural resource management.

Introduction

I would like to open my discussion by commending the U.S. Forest Service for its farsighted effort in drawing together professional archaeologists from across the region to discuss a critical issue of our profession at this time: how to effectively identify the archaeological resources that are located upon the forest lands of the Pacific Northwest.

Ballooning deficits, GAO reports and "20/20" segments aside, I think it is encumbent upon us as professionals to thoughtfully but rigorously examine our goals and how we can effectively pursue them. Rather than being an exceptional event, this should be a normal part of our scientific activities. I think the diversity of perspectives presented here is a testimony to the fact that we are seriously committed to, and have given considerable thought to, improving how we find sites.

While other papers are focused upon the theoretical and practical considerations in designing and implementing survey strategies and tactics, I would like to focus my discussion primarily upon the legal and procedural requirements. I do this for two reasons. First, our agency is involved on a daily basis with many federal agencies, including the Forest Service, in regard to Section 106 compliance issues. The first critical threshold in the compliance triad of identification, evaluation and protection pertains to issues of survey requirements, design, implementation and results. Secondly, legal requirements prescribe the selection and acceptability of particular inventory strategies and tactics that can be ultimately adopted for cultural resource management purposes by federal agencies.

Given the time limits of this presentation and the complexities of the compliance process and law, what I would like to do is emphasize several points as they pertain to this conference. The focus is upon Section 106 and Section 110 of the National Historic Preservation Act, especially as they pertain to the identification process.

Let me first read an order from the Forest Service, Washington, DC:

> To Forest Officers in Charge:
>
> ...the President of the United States is "authorized, in his discretion, to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic and scientific interest that are situated upon the lands owned and controlled by the Government of the United States to be national monuments..."
>
> The importance of taking steps to preserve these objects has become very apparent, and as soon as possible I wish you would report specifically upon EACH [site] or natural curiosity in your reserve, recommending for permanent reservation ALL that will contribute to popular, historic, or scientific interest. The report should consist of a complete and detailed description of the [site] or feature, explaining why it is of interest and the necessity for special measures to insure preservation...A map showing its exact location by legal subdivisions, if possible, together with topographic features and character of cover should accompany each report and should show plainly the area recommended for permanent reservation. In all cases, the areas selected should be the smallest compatible with the proper care and management of the [site] to be protected.
>
> Signed, Gifford Pinchot, Forester, 21 November 1906

Aside from the historical interest in an order approaching 80 years old, which I think indicates the time depth to which the Forest Service has shown a documented interest in the protection of historic/archaeological properties, I would like to note the significance of the words "each" and "all." A clear theme in preservation law and policy is the emphasis upon finding ALL sites and evaluating EACH in terms of its specific characteristics as it reflects significance in understanding America's past.

With the passage of the National Historic Preservation Act and its later amendments, we have the creation of a comprehensive program involving all levels of government: federal, state, and local. The two sections which clearly address survey by federal agencies and consideration of project impacts upon significant historic and prehistoric archaeological sites are Sections 106 and 110.

Section 110 states: "...in cooperation with the State Historic Preservation Officer for the state involved, each federal agency shall establish a program to locate, inventory, and nominate to the Secretary [of the Interior] ALL properties under the agency's ownership or control by the agency, that appear to qualify for inclusion on the National Register."

This clearly requires the agency to actively establish a program to affirmatively locate, evaluate, and nominate to the National Register ALL properties that meet National Register criteria under its control.

Section 106 states: "The head of any federal agency...shall, prior to the approval of the expenditure of any federal funds on...(an) undertaking or prior to the issuance of any license, as the case may be, take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register."

Section 106 and its implementing regulations (36 CFR 800) establish the consultation process requiring the Advisory Council and the SHPO to review and comment upon the effects of an agency's undertaking upon National Register or Register eligible properties.

Agency compliance with its Section 106 responsibilities as it pertains to survey requirements involves consultation with the SHPO, review of published listings of the National Register and other relevant background information, and contact with organizations that are knowledgeable about the area to determine what resources are known to be within the project's impact area.

Consultation with the SHPO is a crucial link since the SHPO's role is to provide the agency with information on any known resources within the project area, including inventory properties, information on previous surveys performed and an assessment of their quality, and importantly, provide a recommendation as to the need for a field survey along with recommendations for survey methodology and the appropriate boundaries of the survey universe (36 CFR 800.4).

The Clearance Model Approach

While Section 106 and 110 represent distinct programs and the procedural requirements of 36 CFR 800.4 specify a discrete series of steps and decision-making all too often for some agencies, they may be pragmatically joined into what some may term "The Clearance Model Approach to Cultural Resource Management."

In this model, Section 110, which mandates an agency-wide program to locate all eligible properties, is only evident as acreage counts or sites found during Section 106 compliance actions. Frequently, the discrete steps in the consultation process are truncated by the complete survey of each undertaking regardless of known and expected archaeological potential and site identification, and evaluation may be limited by redefining project boundaries to exclude the resource and hence short-cut the process.

While there are some short-term benefits from this type of approach, namely, obtaining a "Clearance" or "Sign Off" letter, there are also some significant long-term losses.

In the long run, for those agencies that adopt this type of approach, it is a lose-lose situation. The resource base loses since this type of firefighting approach does not promote comprehensive long-term planning for the management of the resource base. Given the piecemeal approach, it is often impossible to draw any conclusions as to what the resource base is. This is compounded when properties are excluded from the project boundaries and thus are never evaluated, but rather remain in inventory status indefinitely.

Similarly, when Section 106 survey activities are substituted for Section 110 program requirements, the agency's historic preservation program is held hostage to the vagaries of other planning selection criteria and significant properties may be ignored for years.

It is also a losing situation for the agency and its archaeologists since the only time the agency deals with archaeology and historic preservation is during the crucible of environmental review and planning and the necessarily controversial process of resolving competing land use goals and ideas.

Insofar as predictive modeling is interjected into the Clearance Model of CRM, it has the potential to be a replay of the past controversies, exposes, and ill feelings that we should be putting behind us. We have already had a taste of that with the McKinley Mine controversy. Regardless of the particular merits or faults of a specific

predictive model, there is enough debate within our own profession to potentially kill off the concept of predictive modeling before it can be fully developed within the framework of our profession's process of scientific debate. The very existence of a substantial debate within our profession may cause some agencies to shrink from controversial topics to "tried and true" methods to implement the Clearance Model and hence limit innovative approaches.

Considerations for the Future

What is the answer? There isn't one yet. I hope conferences such as this one can help define a concensus approach that both the professional community and the agencies can work together to develop, test, and implement with the support of the interested public. Let me offer some ideas for your consideration as we work together in the days ahead:

First, let us break out of the Clearance Model Approach to CRM. This means we will have to unfold Sections 110 and 106 requirements. Agencies will have to develop a distinguishable historic preservation program separate from their day to day compliance activities and Section 106 responsibilities. This would also mean for Section 106 surveys to develop some rigorous research designs that would stipulate specific survey tactics for given environments and would feed the results back into the research design.

Second, let us recognize a basic aspect of the law; the necessity to identify ALL National Register eligible sites and develop methods to effectively accomplish that aim.

Having made these basic points, I would like to offer the following comments for your consideration:

Predictive modeling has a role to play in archaeology. It has an important role in the evolution of our theoretical thinking for creating an understanding of and explanation for prehistoric adaptations. It may also have an important role in the field of cultural resource management, specifically in regard to Section 110. This would be to use predictive models to develop a priority listing of locales to examine as part of a long-term program aimed at surveying all an agency's holdings and in identifying all National Register eligible sites under its control, within the framework of a reasonable annual cost.

We should also consider the development of other types of predictive models within the framework of this kind of approach. For example, the development of predictive models of vandal's behavior, territorial ranges, seasonal movements, and trade and information exchange networks or predictive models of natural attritional forces to focus our efforts upon protecting sites endangered by natural forces or exposed by them would be of great benefit to CRM. In the final analysis, we may find that in the terms of one of the other great debates that characterizes our profession, we may need more predictive models not fewer.

Finally, we and the agencies should recognize that field surveys as a part of the Section 106 process will be a part of the CRM process for the foreseeable future. The challenge is to integrate their selection and results in a meaningful way into long-term comprehensive research and planning and the validation of predictive models.

PREDICTIVE MODELING AND CULTURAL RESOURCE ACTIVITIES: EXAMPLES FROM OREGON

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Abstract

Critical review of three predictive models constructed as cultural resource management tools indicates several serious deficiencies in the models and how they are implemented. Problems detected include a structure which precludes model modification because of the low probability of acquiring new information and a lack of allowance for the off-site archaeological record. Suggestions for improvement include substantial alteration of the manner in which the models are tested and allowances being made for the off-site record.

Introduction

The *issue* of conserving archaeological resources has been reduced, unfortunately, to several *points of view.* On the one hand, we have academic-based archaeologists who want a representative sample of all types of archaeological resources protected (e.g., Dunnell 1984; Lipe 1974). On the other hand, we find agency-based archaeologists who must sacrifice some cultural resources in order to fulfill their resource management functions. Given that many of the latter were trained at the time when our perception of the archaeological record was changing from one of "sites" to one of "artifacts are continuously distributed across space, and differ only in the density of their occurrence (cf. Dunnell and Dancey 1983 and references therein), many land-manager archaeologists are perhaps more comfortable with using the site concept of the archaeological record. It is precisely these managerial archaeologists who must convince the other resource managers in their respective agencies that cultural resources are valuable. I find that a thankless task and one wherein the managerial archaeologists must keep both sides—the resource managers and the academic archaeologists—happy.

One technique that I, as an academic archaeologist, use to evaluate the performance of agency-based archaeology is to assess whether it is state of the art. Of particular relevance to this conference is an evaluation of how predictive modeling is used as a cultural resource management tool. Such an evaluation is certainly not unique to this conference or the Pacific Northwest, as many of the points I raise below have been discussed at length by others (e.g., Ambler 1984; Berry 1984; Dincauze 1978; Gillio 1984; Tainter 1984; Wildesen 1974). The key issue is, nonetheless, that predictive modeling is becoming a major cultural resource management tool. I therefore believe that the more discussion generated about these tools, the better the end product will be. I firmly believe that none of us want to inadvertently destroy cultural resources, and my discussion is directed accordingly. I have chosen three predictive model-inventory plans written for Oregon National Forest lands for discussion here, and will assess these plans from a perspective that I believe represents the state of the art in archaeology.

Predictive Models in Oregon

Carl Davis (1983), Susan Marvin (1983) and Michael Reagan (1984) have produced site inventory plans for the Deschutes National Forest, the Mt. Hood National Forest, and the Wallowa-Whitman National Forest, respectively. These plans share several common elements. All are for lands in Oregon and all use data on the spatial distribution of physiographic (climatic, floral, faunal, topographic, geologic) variables and known archaeological sites to stratify their respective regions into three or four sampling strata. Each stratum is characterized as having a high, medium, or low probability of containing archaeological sites. There is nothing wrong with this; so far, things make sense with one possible exception. It is unclear how representative the known archaeological record is for any of these regions,[1] and thus using the known archaeological record to predict where as yet undiscovered archaeological resources might exist may be fallacious. (See Kohler and Parker 1986; Nance 1983.) For example, Ambler (1984:141) has suggested recently that while "we can predict likely locations for sites, [we often] cannot predict locations where sites are absent." Dincauze (1978) came to the same conclusion several years earlier (See also Berry 1984).

The authors of the plans suggest that the intensity of the act of inventorying cultural resources can be propor-

tional to the probability that sites exist in a particular stratum. That is, they suggest we can survey 100% of the acreage included in the strata deemed to have a high probability of containing cultural resources, we can survey about 50% of the acreage deemed to have a medium probability of containing cultural resources, and we can survey about 5% of the low probability acreage.[2] I perceive this to be the first of three major flaws in the plans (cf. Figure 13). The authors of the plans state that this proportional surveying tactic "will meet the spirit and intent of the Section 106 compliance procedure for a complete resource inventory" (Davis 1983:11; Marvin 1983:36). I view this statement as an *interpretation* of the relevant legislation made from an "economically feasible" or "cost-effective" (Davis 1983:4) perspective.[3] To be sure, the National Advisory Council on Historic Preservation (1980:8) concurs with such an economic perspective (see also King 1984a, 1984b), but simultaneously I believe that the Council should not concur that the sampling design, *as implemented,* produces a *complete* inventory or an inventory that is statistically representative of the archaeological resource base (cf. Advisory Council on Historic Preservation (1980:15).

The second serious flaw I perceive in the inventory plans is related to the first. While the authors suggest their plans can be modified as new data are acquired, I believe they will find little data that indicate such modification is necessary because their sampling plans are virtually self-fulfilling prophecies. That is, the archaeologists following these designs will find high frequencies of sites in High Probability areas, low frequencies of sites in Medium Probability areas, and very few sites (if any) in Low Probability areas, not only because this is no doubt *more or less* how the sites are, in fact, distributed, but because of the direct correlation of sample size and probability per stratum (Figure 13). The sampling designs are of the statistical precision type couched in predictive terms;[4] they are meant to estimate parameters of commonly occurring phenomena and are based on a (as yet) suspected autocorrelation of physiographic variables and cultural remains (Nance 1983:292-293). As such, the designs are not meant to find examples of rare phenomena and thus cannot be tested for their validity or the representativeness of their results in terms of the *total* range of variability of sites.[5] The inventory plans, as written, simply are not discovery designs (Nance 1983:292).[6]

Clearly, on the one hand the rarely occurring kinds of archaeological resources,[7] most of which may occur in the strata deemed Medium and Low Probability, will not be found. On the other hand, many of the commonly occurring kinds of archaeological remains, most of which will occur in the High Probability strata, will be found. The result is that much potentially redundant data will be recorded while rare data will be lost. I believe that the Advisory Council should not concur with an inventory design, the validity of which cannot be ascertained and which produces the kind of results I have described. Certainly, archaeologists desiring that a representative sample be preserved would view these plans unfavorably (e.g., Ambler 1984; Berry 1984; Dunnell 1984; Lipe 1974), as I do.

Another reason that I believe the Advisory Council should not concur with the designs is found in the fact that these designs are clearly founded on the site concept (cf. Dunnell and Dancey 1983; King 1984a, 1984b; Lyman, this volume). I perceive this as a third flaw in the plans, but it is a different kind of flaw from the first two. This third flaw is especially pernicious because it concerns an operational conception of the structure of the archaeological record that is, in many cases, no longer state of the art in archaeology (See Lyman, this volume). As well, much of the cultural resource legislation is built around this conception of the archaeological record (Dunnell 1984), and fixing this flaw may, then, be difficult.

Davis (1983) does not define the term "site." Marvin (1983:51) defines a site as

> being a cluster of four or more cultural objects within 1/4 acre when soil surface visibility is 20 percent or greater; locations or former locations or structures or buildings; or places of specific activity such as rock art, peeled cedar trees, burials, cairns, rock alignments, roads, or trails.

Marvin presents no data to support the density of cultural objects criterion, and thus I wonder if it is truly appropriate to the archaeological resources in the Mt. Hood Forest. The density of cultural objects criterion she proposes translates into four objects in 1011 m^2 (1 per 250 m^2), or four objects in a 32 X 32 m block of space (1 per 16 X 16 m) equals a site. I suspect that many "sites" have thus been unconsciously walked over and not recorded even with this criterion in place.

Reagan (1984) lists as sites phenomena called trails, camps, cabins, occupation sites, lithic scatters, dams, ditches, rest points, cutting areas, and a plethora of other kinds of functionally defined loci. How these are to be recognized empirically is not specified. In fact, Reagan (1984:17) defines a site as "the focus of a cultural resource." This statement is tautological. A clue is provided, though, when Reagan (1984) suggests that "the size of the site is determined by the distribution of artifacts and/or features on or below the surface." Other than this statement, he gives no empirical criteria for defining site boundaries and distinguishing off-site areas. Reagan (1984:18) does suggest sites will be eligible, may be eligible, or are not eligible for inclusion in the National Regis-

ter (i.e., are, may be, are not "significant"), but lists no criteria or techniques for evaluating the eligibility of particular sites.

Davis (1983), Marvin (1983) and Reagan (1984) do not mention if or how we are to deal with isolated finds. This deficiency, in conjunction with the lack of an operational definition of "site," could present problems. How many artifacts in a given spatial area are required before that area is recorded as a site? Certainly I think that the attempt by Marvin (1983) noted above to provide such a definition is correct in intent. The importance of providing a practical and workable definition of "site" seems clear: if sites are to be recorded but not isolated finds, then the archaeologists must know which they are dealing with every time an artifact is discovered. As I have argued elsewhere (Lyman, this volume), I believe that the distinction between sites and isolated finds should not be made if the latter are to then be automatically written off and ignored in resource management decisions. In fact, when it is realized that sites are simply collections of isolated finds (discrete objects) that happen to be spatially closer to one another than a collection of artifacts that are called isolated finds, it becomes difficult for me to conceive how anyone truly interested in prehistory could ignore isolated finds. Another way to make this point is to note that one artifact, when considered by itself and regardless of its spatial relationships to other artifacts, is usually not very important or informative whether it is in a site or not.

My opinion of the three inventory plans I have reviewed here is that (1) they are not state of the art in terms of what our modern perception of the archaeological record is; (2) they are not serving the profession of archaeology nor the public by seeking to preserve a representative sample of the archaeological record; (3) they are not truly workable solutions from practical ("site" not defined with justifiable empirical criteria) or logical (designs are not testable) standpoints; and (4) they are written strictly from a "cost-effective" perspective and not from a strictly conservation-oriented perspective.[8]

Suggested Alterations

An obvious alternative to the plans I have reviewed is to construct more sophisticated predictive models for the Pacific Northwest forests, models that are on the level of sophistication that is evident in predictive models being developed for Southwestern Region forest (Cordell and Green 1984). There are two difficulties if such an alternative is chosen. First, many data must be collected that are not yet available (e.g., paleo- environmental, chronological, etc.), and much time and money will have to be spent to collect that data and even more time and money will be required to integrate all of the data into a predictive model. It is then relevant to consider whether the Forest Service wants to pay for more complete (100%) surveys, or pay for more sophisticated and precise models. I would not want to hazard a guess, at this time, as to which would cost more. A compromise wherein some of both—sophisticated model building and complete survey—might be cheapest.

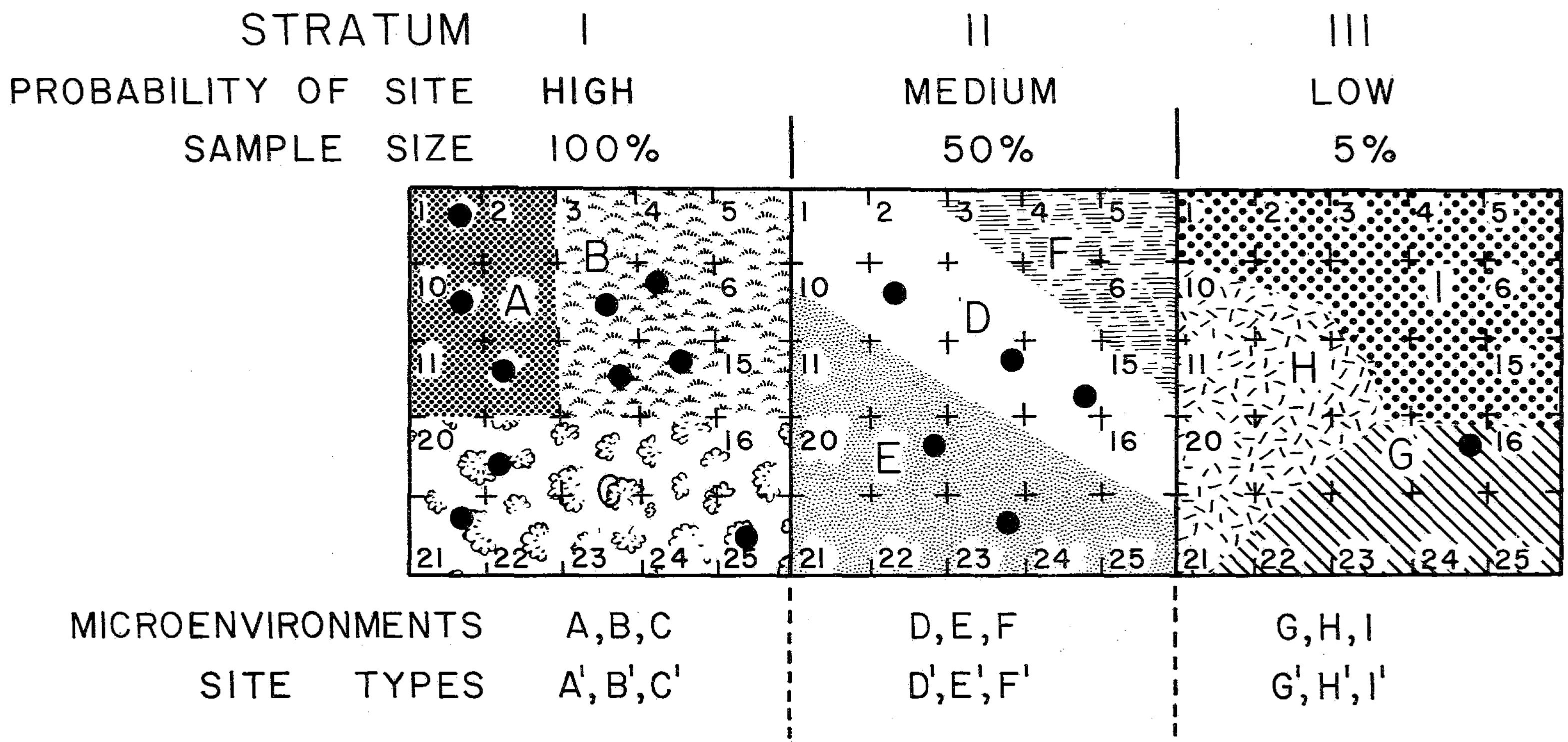
The second difficulty that I perceive is not so obvious as the first. The cultural resource management legislation was not written to insure that archaeological research would be funded by governmental agencies (Advisory Council on Historic Preservation 1980; Dunnell 1984). The predictive models being developed by archaeologists for Southwestern Region forests are very sophisticated research tools, as a recent synopsis of predictive model building suggests they must be if such models are to be good, precise, and valid predictors (Kohler and Parker 1986). The difficulty thus may become one of considering the ethics of people like myself—an academic archaeologist interested in research—asking the Forest Service to spend their limited funds on what will ultimately be long term, very sophisticated, and very costly *research* in order to produce the desired predictive models.

Many of the points I have raised concerning these plans have been raised by others in the context of recent discussions on the Office of Surface Mining Enforcement and Regulation Programmatic Memorandum of Agreement (Brose 1984; Condie 1984; Glassow 1984; Holt 1984; King 1984a, 1984b; Klesert 1984; Nelson 1984; Plog 1984a, 1984b). There are some advantages to this Mining plan not apparent in the Forest Service plans I discuss above. In brief, these advantages are: (1) if done correctly, predictive modeling will cause archaeologists to look in areas and/or for cultural resources that may not otherwise be obvious; (2) allowances and procedures for dealing with the off-site archaeological record are built into the Memorandum of Agreement; and (3) complete (100%) survey of an area is not automatically precluded and can be requested, when warranted, by a review and appeal process (See especially King 1984a).

Of course, the advantages to the Mining plan are only good if they are exploited and used by the archaeologists involved. For example, I see little option for the third advantage (100% survey) of the Mining plan in the Forest Service plans, and explicit denial of this option by Reagan (1984; see note 2). I strongly recommend that the Cultural Resource Inventory Plans written for Region 6 National Forests in the future incorporate the advantages listed above.

Figure 13: A hypothetical land unit illustrating the fallacies of the USDA-Forest Service archaeological site inventory plans. Each "stratum" contains three microenvironments (A through I). Each stratum has been divided into 25 equal-sized quadrats (denoted by small numbers and grid ticks). Large dots represent sites. Five independent samples were randomly drawn from each stratum, with sampling fractions as follows: Stratum I: 100%; Stratum II: 50%; Stratum III: 5%. The number of sites found and the sample units drawn are as listed (note: if a quadrat with a site in it was chosen, the site was "found").

Sample	Stratum	Quadrats Surveyed	Sites Found Per Microenvironment
1	I	all	all
	II	7,4,11,3,22,8,1,19, 17,10,12,9,25	D–1; E–1
	III	12	none
2	I	all	all
	II	23,1,15,10,25,19,4, 6,12,2,5,17,21	D–0; E–2
	III	20	none
3	I	all	all
	II	15,3,14,13,10,5,12, 2,1,18,22,6,11	D–2; E–0
	III	3	none
4	I	all	all
	II	22,4,6,11,20,19,25, 15,14,12,18,5,10	D–1; E–1
	III	8	none
5	I	all	all
	II	20,15,25,21,7,12,6, 17,3,11,23,1,14	D–1; E–1
	III	25	none


STRATUM I II III
PROBABILITY OF SITE HIGH MEDIUM LOW
SAMPLE SIZE 100% 50% 5%
A B C D E F G H I
MICROENVIRONMENTS A,B,C D,E,F G,H,I
SITE TYPES A',B',C' D',E',F' G',H',I'

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NOTES

1. Marvin's (1983) predictive model is based on the distribution of only 58 sites. The Mt. Hood Forest is approximately 1,060,000 acres in extent, of which 116,000 acres (10.9%) have been surveyed. Apparently "over 300 sites" have been recorded in this forest (Marvin 1983). I can not help but wonder about the validity of the predictive model and inventory plan prepared for the Mt. Hood National Forest.

2. Reagan (1984:9-10) goes so far as to state that he feels a 100% sample of high and medium probability will result in the discovery of *"all* of the locatable sites" (emphasis added), and thus a complete inventory will be generated that complies with the cultural resource laws.

3. The issue of cost-effectiveness versus the responsibility of the Forest Service has seen some discussion in Day (1978, 1979), Downer (1979), McGuire (1979) and Rush-in-Bell (1979).

4. Berry (1984:845), for example, has noted that "a misunderstanding of predictive modeling constitutes an *outright threat* to archaeological sites due to the potential use of such models as substitutes for clearance surveys." (emphasis in original).

5. My colleague, Robert C. Dunnell, refers to predictive modeling in this context as the "let's think like a prehistoric human" approach couched in statistical trappings.

6. A separate issue that warrants consideration concerns how these designs are, in fact, implemented. What if, for instance, in some cases *only* the high probability areas are surveyed while the medium and low probability areas are *completely* ignored due to financial and temporal limitations?

7. I perceive a "rare element" as an archaeological resource that is somewhat unique for a given geographic area. "Uniqueness" might thus be dictated by how the geographic area is defined (see discussion of mastodon Paleoindian sites in Lyman, this volume). On one hand, Ambler (1984:142) argues that "no sampling design can predict the presence or location of rare, unusual, or unique sites. By their very nature of being rare, such sites assume an importance beyond their numbers in terms of their potential for elucidating the past." On the other hand, King (1984b:87) argues "intensive survey in and of itself is no guarantee that all sites will be found. On the contrary, I believe it is much more likely that all sites will be found using predictive models because a modeling approach perforce requires the archaeologist to figure out in advance what various kinds of sites should look like and how to find them." Some middle-road between these two extreme views may be the most realistic, and more importantly, the most efficient way to insure cultural resources are inventoried.

8. Note that a plan similar to those reviewed here has recently been prepared for certain Bureau of Land Management lands in central Oregon (Wildesen 1984).

REPLY TO LYMAN

Carl M. Davis
Deschutes National Forest

Lee Lyman's (1985, this volume) paper is a useful critique of three Forest Service cultural resource inventory plans developed in Region 6 (Davis 1983; Marvin 1983; Reagan 1981). Lyman's principal criticism is that the plans do not fulfill legal compliance because they are tautological and provide no mechanisms for scientific testing, improvement, and change. Secondly, he contends the plans do not adequately address the "off-site" record nor yield a "representative" sample of the resource base. Thus, the plans do not reflect "state of the art" methodologies, nor do they eschew a resource conservation ethic. Each of these criticisms is briefly addressed below.

I do not believe the complex issue of compliance-level cultural resource inventory planning can be neatly separated into the opposing positions of "academic" and "federal" archaeologists—the former apparently espousing resource conservation and the other resource depletion (Lyman 1985:85). This viewpoint ignores the fact that all archaeologists engaged in fieldwork on state and federal land participate in the same legal-scientific process in which few such black and white distinctions exist (cf. Fitting 1979:83-85, 85-90; Mayer-Oakes 1979). As this workshop demonstrates, what constitutes a "complete" survey, a "representative" sample, "legal compliance" or "state of the art" inventory methodologies is open to a diversity of professional opinion. The wide variation in the quality and utility of recent cultural resource inventories completed by all manner of professional archaeologists in the Pacific Northwest seems ample proof that these issues cannot be reduced to convenient stereotypes.

The concern that current inventory plans are tautological is extremely appropriate. As I have discussed elsewhere (Davis 1985, this volume), based on the results of three years of inventory, the Deschutes National Forest plan was modified to include more extensive random sampling in the medium/low probability zone in order to counter tendencies toward "self-fulfilling prophecies." These recent field tests (Davis 1985) generally substantiate the inventory plan but more in-field survey and statistical testing are necessary before the plan can be adequately evaluated. In any case, the inventory plans necessarily provide for revision, modification and change (Davis 1983:23, 28).

The level of survey coverage in any probability zone, or for any survey project in this region, depends primarily on the size and nature of the survey area and the particulars of the proposed undertaking. For example, in central Oregon inventory coverage ranges from a 10% (cf. Lyman et al. 1984) to 40 to 60% (Davis 1985, this volume) sample of large land tracts, to near 100% coverage of powerline corridors (cf. Toepel and Beckham 1981) and small-scale developments (cf. Johnson 1983; Snyder 1983). In the opinion of the Oregon State Historic Preservation Officer, these various inventory projects fulfill legal compliance. Thus, when viewed in this context, the intensity of field coverage necessary in areas of the forest that consistently yield few cultural sites is problematic.

I hope various levels of field sampling in the medium/low zone, and an adequate level of statistical testing of the data generated, will legitimately demonstrate that it is possible to predict where sites are typically absent in a forested mountain environment, and arrive at a survey coverage that does not generate questionable or tautological results. A vast amount of survey information (generated by a large amount of taxpayer dollars) is already housed in Forest and SHPO files which provide, I think, reliable data about "negative" archaeological space and a legitimate basis for reducing the level of survey coverage in some areas. Lyman's concern is well taken, but he fails to acknowledge the amount of survey work being done (and already done) in the medium and low probability zones, the rigorous nature of these environments, and the small number of sites that are typically found.

As I stated earlier, what constitutes a "representative sample" is an open-ended question in the profession. However, I believe the nature and range of cultural resources are fairly well documented on the National Forests under concern. The results of each year's inventory, and the incidental discoveries throughout the forests, annually confirm this range of variability. If the purpose of sampling is to "estimate parameters of commonly occurring phenomena" (Lyman 1985:86), then I doubt we are missing much. As for Lyman's "rare" or "unique" sites, I am uncertain as to exactly what they are and why they should primarily occur in medium and low probability zones. Whether any sampling scheme can be designed to find them is open to debate. In any case, the amount of information about cultural sites and forest history is surprisingly more detailed (and available) than many people appreciate. The inventory plans are founded on this data base.

How a "site" should be defined is a traditional and recurrent issue in cultural resource management and

archaeology. No "cookbook" definitions exist and the term can mean one thing to the land manager and another to an archaeologist. To clarify Lyman's concerns, on the Deschutes National Forest all archaeological phenomena are recorded on either site or isolated find forms. Find spots with several or more artifacts are recorded as "sites" while those with one or two are recorded as "isolates." Isolated finds are not "written off" as Lyman suggests; the find spot is recorded and, if necessary, tested, and the artifact is collected. Once the data are collected, however, the find spot may be affected by a project.

These inventory data are abundant in both State Historic Preservation Office and Forest Service site and survey files, and inventory atlases. This "off-site" record would undoubtedly contribute to a more comprehensive understanding of prehistoric settlement patterns and adaptive strategies. However, I believe Lyman's criticisms are best directed at the archaeological profession at large, which has yet to fully acknowledge or use this large and expensive inventory data base, rather than at a shortcoming of the inventory process.

Finally, whether the plans are conservation oriented depends on individual perspective. While project level compliance generates a great deal of survey and excavation work for all types of archaeologists, it also contributes to the piece-meal management and rapid demise of the cultural resource base. Thus, a common inventory goal in Region 6 is to finish cultural resource inventories ahead of the environmental review (NEPA) process so the resource base is legitimately considered in Forest planning and management, rather than at the onset of specific projects. Inventory planning provides for more systematic coverage of the forest and helps accomplish this critical goal (Davis 1985). It lies midway between project level compliance surveys and the ultimate goal of deductively-based predictive modeling. In my opinion, tools such as inventory plans which provide for integration with the agency planning and decision making process do far more to preserve cultural resources than the reactive and piece-meal approach with which the profession currently abides.

In conclusion, Lyman rightfully stresses the importance of statistically testing and verifying the premises on which the Forest inventory plans are based. Current efforts are directed toward this goal. Many other issues Lyman raises, however, fall into a troublesome "gray" area which continues to hamper the growth and development of archaeology and cultural resource management, and which will require professional empathy and cooperation to resolve.

REPLY TO LYMAN

Susan H. Marvin
Mt. Hood National Forest

Federal archaeologists are confronted by two opposing desires. On the one hand, the National Historic Preservation Act states that preservation of irreplaceable cultural resources in in the public interest. Thus, Federal archaeologists must convince resource managers that significant cultural resources should be preserved in place when conflicting uses arise. On the other hand, preservation in place of *all* cultural resources gains the archaeological community very little in terms of new information about an area's past culture. Avoidance *ad infinitum* wll provide neither the general public nor the archaeological community with any of the benefits of the knowledge which can be gained from these resources. For archaeological sites, such knowledge is their major value, since they usually qualify for listing on the National Register of Historic Places under Criterion for Evaluation 36 CFR 60.4(d): "that have yielded, or may be likely to yield, information important in prehistory or history."

Contrary to Lyman's belief that Federal archaeologists must sacrifice some cultural resources, no cultural resource on the Mt. Hood National Forest is "sacrificed" without data recovery through methods approved by both the State Historic Preservation Officer and the Advisory Council on Historic Preservation. Since excavation yields the information the site contains, I do not consider data recovery a mitigation method which "sacrifices" sites.

The generally upland forested environments encompassed by the Mt. Hood National Forest have undergone little investigation from the archaeological community. Other than in general terms and untested assumptions, little is known about the prehistory of this area. Only two archaeological sites have undergone substantial excavation as a result of mitigation for proposed project impacts. As an archaeologist who must usually deal with incomplete survey data (in the sense that time and visibility constraints do not permit the complete data collection of the surface manifestations of the site), the detailed and somewhat surprising results of these excavations provided useful data to help in the study of this area's prehistory. Certainly, in-place preservation of a representative sample of this area's archaeological sites is a worthy goal, but without at least some excavation which can provide data on subsistence/settlement patterns and chronology there is no way to determine what *is* a truly representative sample.

We do not, at the present time, know how representative the recorded archaeological sites are for the area simply because the status of the data collected thus far cannot tell us. One does not know the representativeness of a sample unless the variability of the total population is known. The Mt. Hood's Sample Survey Design was based on the data collected for 58 Native American sites. Although over 300 sites have been recorded, the remainder are Euro-American sites, which were not directly included in the analysis because I believe historic site locations are quite often dependent on cultural factors that may override environmental concerns. Since the survey design is based on the associations of specific environmental variables to predict the relative probability of Native American site occurrence, Euro-American sites are included through use of a District Site Atlas and other documents. Admittedly, 58 sites is a relatively small number upon which to base a survey design, but one must start somewhere if the data collected from past surveys is to be rendered useful. The present survey design should be considered as the beginning of a process that will be continually refined.

Lyman is concerned that one of the major flaws of Forest Service survey designs is the use of sampling as a method for compliance with Section 106 of the NHPA. He views such methods as our *"interpretation* of relevant legislation from an 'economically feasible' or 'cost-effective' perspective" (Lyman 1985:86). *Our* interpretation is taken directly from the Advisory Council's interpretation of the legislation upon which they base their review of the adequacy of the identification effort: "the identification effort appears to be conducted at a sufficient level of intensity in relation to the *numbers* and *types* of archaeological properties *expected* to occur in the area" (Advisory Council on Historic Preservation 1980:15, emphasis added). We are faced with the very real problem of too few dollars spread over too many acres to survey. We *must* formulate survey designs wherein we can expect to locate all reasonably locatable sites without having to walk every acre of the project area.

Since Forest Service survey designs are based on data from previously recorded sites, Lyman believes the designs are "self-fulfilling prophecies" (Lyman 1985:86). Contrary to his expectations, we are finding new data that indicate our beginning efforts at formulating survey designs need to be revised. Certainly this was the case for the Mt. Hood National Forest. Our first effort at devising a survey design was completed in 1982 (Marvin 1982). Data collected from the first year the design was used indicated that it needed revision and this was accom-

plished in 1983 (Marvin 1983). Analysis of the new data indicated that present forest openings are not good site predictors. It also clarified the relationship of distance to water with geomorphic features. For geomorphic features where water is a factor, it was determined that sites are almost always found within 300 feet rather than up to 600 feet away as was thought in the first survey design. It was also determined that for some geomorphic features, such as ridges, spur ridges, and saddles, distance to water is not a relevant factor in predicting site occurrence. Data collected since 1983 indicate the survey design needs further refinement, as expected. As more sites are located, more information is added to the data base, more or less variability is introduced, and environmental associations may be clarified or obscured. These must be taken into account if one's objective is to identify all reasonably locatable sites in a cost-effective manner.

I disagree with Lyman's assumption that most rare sites occur in medium or low probability areas. Of the 87 archaeological sites thus far recorded, we have what I would call eight "rare" sites. I consider these "rare" sites either because they occur in such low frequencies on the Forest or because the kind of site found is unexpected for the particular geomorphic feature on which it it located. These include one possible housepit site and three rock shelters—all of which were found in high probability areas for site occurrence. The others are large, relatively dense lithic scatters which occur in areas where only small, sparse scatters were expected. All but one of these were also discovered in high probability areas. Considering the whole concept of rarity versus redundancy in archaeological data being recorded, I believe that we are not even *close* to recording redundant data. We will not reach this stage until the archaeological data of the Forest are thoroughly investigated and such redundancies can be clearly identified. In the meantime, the question of redundancy is irrelevant.

Since we are not covering every acre of ground of the project area using the present survey design, the possibility of missing some rare sites does exist. But this is going to be the case for any survey design which does not require survey coverage of the entire project area. Even a thorough coverage of the entire area does not guarantee that all rare sites would be located due to visibility and site formation process problems. One cannot predict the locations of rare sites without understanding the cultural behavior that produced them. Since no one from the archaeological community has yet made any attempt to undertake an areal investigation of the cultural patterns that produced the Forest's archaeological sites, one cannot expect us to be able to predict where such rare sites are likely to occur.

The survey designs are necessarily founded on the site concept because sites can be determined eligible to the National Register and impacts to them can be mitigated through the Section 106 process. Although objects (i.e., isolated finds) can also be determined eligible to the National Register, a key concept of eligibility is *integrity* (National Park Service 1982) and spatial integrity is difficult to demonstrate for an isolated artifact. On the Mt. Hood National Forest, all isolated finds are first confirmed as such in the field by the surveyor's intensive examination of the surrounding area. If determined to be truly an isolated find, it is recorded on the appropriate form. With the soil visibility problems encountered on the forest, many of our sites are first discovered by the occurrence of a single flake; it is only after further intensive search has uncovered more flakes or artifacts that the site's existence is confirmed.

Lyman seems to have overlooked my quotation of Deetz (1967:11) for defining a site as "a spatial concentration of material evidence of human activity." I expanded on this definition to characterize a site because we must take a pragmatic approach to this concept when it has to be operationalized in the field by trained technicians and resource managers. Again, from a pragmatic standpoint, there must be a breakpoint between isolated finds and sites. As stated previously, it would be extremely hard to determine most archaeological isolated finds as eligible to the National Register; therefore we must concentrate our management on sites. The purpose of the density criterion is to alert technicians in the field that as few as four "cultural objects" may constitute a site and should be recorded as such.

Archaeological sites must "yield, or may be likely to yield, information important in prehistory or history" (National Park Service 1982:1). This is a requirement of the National Register Criteria for Evaluation 36 CFR 60.4. If they are not likely to yield such information then the taxpayers' money should not be spent on mitigating impacts to such sites or isolated finds. Not only must sites meet this criterion, they must have *integrity*.

> To be listed on the National Register of Historic Places, a property must meet Criterion A, B, C, or D *and* must possess integrity. Integrity is the authenticity of a property's historic identity, evidenced by the survival of physical characteristics that existed during the property's historic or prehistoric period. If a property retains the physical characteristics it possessed in the past then it has the capacity to convey association with historical patterns or persons, architectual or engineering design and technology, or information about a culture or people. (National Park Service 1982:35).

> The retention of the pattern of deposited materials is important in evaluating the integrity of materials in archaeological sites because often much of the important information that a site contains is based on the distribution of features and artifacts within the site (National Park Service 1982:36).

Thus, if it can be demonstrated that the "pattern of deposited materials" in a site has been so disrupted by modern activities or natural phenomena that its spatial integrity is lost, then even if the site meets Criterion D for evaluation, it cannot be considered eligible to the National Register. Lyman's complaint that this concept cannot be operationalized is simply a repetition of criticisms by other archaeologists who have not had extensive experience with the Section 106 process nor with the National Register evaluation process. This concept is defined by the Keeper of the National Register to guide the wise use of the taxpayers' dollars in managing cultural resources.

In conclusion, our present survey designs may not be "state of the art" but they are a beginning and it is to be hoped that this conference will provide the input necessary to more closely realize the "state of the art". Since none of the sites protected thus far are considered redundant I can only conclude that we are indeed preserving a representative sample of the archaeological record (no sites have been determined ineligible to the National Register on the basis of redundancy in the data they may contain). The survey designs are indeed practical and workable since we *are* surveying and managing these sites on a daily basis. The designs explicitly explain how the survey process is carried out and they are conservation-oriented. By undertaking surveys in the earliest stages of project planning we are allowing more time to work out solutions for conflicting resource use which will preserve sites in place or undertake an approved data recovery program. The chance of foreclosing alternatives or the Advisory Council's ability to comment (required by 36 CFR 800.4) is lessened considerably when surveys are undertaken for project planning areas; by the time impact area locations are determined we are seriously jeopardizing the Advisory Council's opportunity to comment on the undertaking. We must, of necessity, be cost-effective if we are to defend spending the public's money on managing cultural resources.

COMPUTERIZED GEOGRAPHIC

INFORMATION SYSTEMS

FOREST SERVICE ENVIRONMENTAL MAPPING SYSTEMS AND THEIR COMPARATIVE USEFULNESS IN ARCHAEOLOGICAL PREDICTIVE MODELING

Jeff LaLande
Rogue River National Forest

Abstract

Successful implementation of any predictive model or sampling strategy for locating archaeological sites depends on several design factors. One of the most crucial of these involves the definition of pertinent environmental variables and their correct interpretation/delineation onto maps. Region Six of the Forest Service currently uses (or is scheduled to begin using) three major environmental data mapping systems which may be helpful to archaeologists: the Total Resource Inventory System, the "R-2" mapping system, and the Geographic Information System. Each of these three systems is described and their comparative advantages/disadvantages for predictive modeling are discussed.

Successful implementation of any archaeological predictive model or survey strategy obviously depends on how well we have designed our particular system. One of the crucial factors in the design process involves the adequate definition of pertinent environmental variables and their correct interpretation from (and transfer onto) maps of the land we wish to study. How closely does our model (whether deductive of inductive) correspond to the natural and cultural world it is meant to reflect? The ideal environmental map would actually see on-going use through all phases of archaeological survey, from the design stage through field testing to continued (and updated) use by the land-managing agency—and, as such, it should be as accurate, as adaptable and as cost effective as possible.

Region Six of the Forest Service currently uses (or is scheduled to begin using) three major environmental data mapping systems which may be helpful to archaeologists: the TRI system, the R2MAP system, and the GIS. I will describe each of these and briefly compare their usefulness to the task at hand: archaeological inventory and predictive modeling on the National Forests of the Pacific Northwest. The first two systems are currently available; and, in some places and situations, they are being used by Forest Service archaeologists—although not, so far as I know, for complex modeling projects. GIS, the third system, probably will soon be available to the National Forests, but in an, as yet, undecided form and at an, as yet, unknown level of complexity. Each of the three systems has "pluses" and "minuses." All of them, however, have in common the ability to provide at least a base level of environmental information. They will store, display and permit some manipulation of mapped data—data on such factors as soils, slope and aspect, hydrology, elevation, vegetation types, and so on. Our major question is, "Which of these systems will work best for us?"

So far, this presentation probably sounds as if I really knew what I was talking about. I assure that nothing could be further from the case. Although I am speaking about a "technical" subject, this really is *not* a "technical" paper. I have known a little about the TRI and R2MAP systems for a long time; but, I confess that I first heard the initials "GIS" when Jim Keyser called me up a couple of months ago to give me my marching orders for presenting a paper at this conference. Since that time, I've learned a bit more about the two current systems and a lot more about GIS. Depending on how you measure such things, that may not be an impressive amount of knowledge. So, in this presentation, I want to take a kind of "neophyte-generalist" approach to the whole topic. After briefly touching on the development and function of the two current systems, I will, for reasons that I hope will be self-evident, spend most of my time discussing GIS.

The TRI System

TRI stands for "Total Resource Inventory"—a somewhat grandiose name for a system which, in practice at least, has promised more than it has delivered. TRI is a resource data mapping and storing system confined to the Pacific Northwest Region of the Forest Service. TRI was initially developed in the mid-1960's by a Ranger District employee on the Willamette National Forest to display timber management information: timber type maps, sale layout, reforestation project boundaries/dates/success-rates, and so on—in short, the whole cycle of timber management activities that occurred on that District, one of the largest "board-foot volume" producers in the entire National Forest System. This new information-storage system was soon adopted, expanded and implemented by

the Regional Office, as a way to track other resources as well. A bit of historical perspective here: then (as now with GIS), TRI was a response to critical overload in the sheer amount of resource management data—data which had proliferated at a dizzying rate since the onset of the agency's post-war increased timber sale program. Before the advent of TRI on a Region-wide basis during the late 1960's, the Forest Service was still using the old "atlases" (first begun when the outfit took over administration of the National Forests in 1905). These were separate atlases—each one an often unwieldy collection of color-coded, varied scale, and intricately folded maps, often bound together between hard cardboard, scrap plywood from the District's carpenter shop, or whatever else happened to be handy. They recorded a surprisingly wide (and now, often historically valuable) variety of resource information. A typical Ranger District would keep a timber-type atlas, a "cut-over" atlas, a grazing atlas, a "burned areas" atlas, and others.

TRI was definitely a better way. It used aerial photograph maps (soon improved with the use of orthophotos) to keep track of relevant resource management information for relatively small geographic units called "compartments." (These are based on prominent drainages or other easily-defined areas.) Compartments are further divided into "cells," which are used by means of manually-placed mylar overlays to display quite specific information. Some of the TRI information "fields" include:

- stand/tree size-class
- average slope typical of that cell
- land status (ownership)
- ecotype class
- soil type
- wildlife browse
- aspect of terrain features
- harvest/reforestation data

and a variety of other data.

The four major components ("hardware" if you will) of TRI are:

a. a manual, layered mapping system based on orthophotos;
b. an automated, multiple-attribute resource data base (based on "cells");
c. a manual system of resource activity records; and
d. an archiving system based on micrographics technology (a fancy term for microfiche files and readers).

The system requires updating with new orthophotos every few years; this involves the tedious task of manually redrawing the cells.

TRI is an intermediate step on the path from the old library of bulky atlases to the automated data-base information system of the 1980's. It is aimed specifically at project-level work, but the information is available (although not conveniently so) for more extensive land areas. The Region invested a great deal of time, energy and funds into the development and implementation of the TRI system. There was the usual resistance to change, to "something new," to the perceived increase in "busy work" that TRI represented to some District and Forest personnel. But, although the current system is not as advanced as its originators had hoped it would be, TRI has served agency resource managers adequately for a number of years. On some Forests, archaeologists have utilized TRI largely: (1) to document acres of cultural resource survey, (2) to display presumed areas of high/low cultural resource potential, and (3) to record, by means of a "confidential data" field, known site locations; other Forests have not used TRI for CRM purposes at all.

What are the advantages of TRI for our purposes? For one, it is in place and available now. For another, TRI will display information for very small units of land—a real plus for accuracy in predictive modeling. In addition, it is a fairly standardized Region-wide system (although there is unavoidable variability between Forests and Districts on how current or complete their TRI records actually are). On the debit side, of course, TRI is an outdated technology, one that would prove cumbersome to use in future large-scale modeling projects, and one that probably will not continue, at least not in its present form, to function as a significant factor in the Region's resource management activities.

The R2MAP System

The R2MAP system represents the next generation of data mapping to follow TRI. "R2" stands for Region Two, the Forest Service's Rocky Mountain Region (not surprisingly, home of the agency's large mainframe computer in Fort Collins, Colorado). R2MAP developed out of the Forest Service's nationwide Land Management Planning (LMP) effort of the late 1970's and early 1980's. This effort (which continues today) was, in turn, a direct response to the requirements of environmental legislation enacted in the 1970's; it has been described as the largest, most detailed, and most comprehensive land-use planning project of its kind in world history. However, due to the

decentralized organization of the Forest Service, each Region—and Forest—has approached the task of tracking their planning data somewhat differently. Here in Region 6, R2MAP was adopted by over half of the nineteen Forests. Most of the other Forests in this Region use similar land management planning map systems such as the MtHoodMap (essentially an R2MAP with a few added capabilities) and the RIDSPOLY systems.[1]

As would be expected for a system used in broad-scale land management planning, R2MAP was designed for areas far larger that the typical TRI compartment (i.e., an entire National Forest). The R2MAP display system employs automated "digitization" (i.e., simply numeric symbols) of environmental data onto grid maps. The finished product appears as a computer printout of clustered numbers, each representing a cell; boundaries and most other linear features must be drawn in by hand. R2MAP cell sizes vary between the National Forests from 3-acre to 20-acre units. Once a Forest has decided on a given scale and cell size, the Forest's plan mappping is locked into that size for all subsequent data storage and analysis. R2MAPping utilizes separate layers of computerized data: a timber productivity class layer, a recreation opportunity layer, a slope percentage layer, etc. The Rogue River National Forest's R2MAP has over 100 such layers. The number of layers is open-ended; however, the sytem is severely constrained by its inability to overlay and analyze more than a very few layers at one time.

Aside from limited use by archaeologists as part of their Forest's LMP effort (such as a layer showing current interpretations of the land base's varied "cultural resource potential" or "site probability" levels) R2MAP's potential cultural resource applications appear to be quite limited. R2MAP works best with large land areas; at first glance, we may justifiably hope to put it to work for us. I am about to embark on an attempt to use available R2MAP data to help design my Forest's cultural resource inventory strategy, and I am not particularly looking forward to that prospect. Although it does employ computers to do much of the number-crunching and other drudge work, R2MAP is still quite labor-intensive throughout much of the sytem's sequence. It is almost worthless for analysis of small areas of land (so, don't look for possible "spin-off" intra-site patterning studies here), and the system, because of its polygon/grid data storage and display format, cannot record linear or "point" data. Further, it is neither a standardized system (its application on the Forests varies considerably), nor is it used by some units at all.

R2MAP and related systems will probably continue to function through the current National Forest planning cycle, into the late 1980's. Like TRI, it will then most likely be absorbed into a nation-wide, automated data-mapping system.

GIS

Now, to relieve a few of you of what little suspense this presentation may have created in your minds: GIS stands for Geographic Information Systems. It is a generic term for a whole range of automated environmental data management systems that have evolved out of the Computer Revolution of the 1970's. Some GIS components and capabilities developed directly out of NASA satellite projects; other resulted from the combined efforts of university-based researchers, computer consultants, and urban planners, particularly in the northeastern United States. GIS soon entered the consciousness of Federal land-managing agencies. Among them, the Forest Service formerly held the lead in GIS study: scoping what a good system would "look like," how it would work, how much it would cost. Then along came the Land Management Planning effort of the past ten years. Feeling the pressure of time and limited funds, the organization decided to use in-place systems for this major task. Consequently, various Department of Interior agencies (the Fish and Wildlife Service and the Bureau of Indian Affairs in particular), as well as the Department of Defense, have progressed further down the road towards designing a workable GIS. The Forest Service "culture lag" in this area is not necessarily bad; it may, in fact, provide us with an otherwise lost opportunity.

Before giving a very abbreviated discussion on "What is GIS and how does it work?," I want to re-emphasize that I am not an expert, not even a sorcerer's apprentice, on Geographic Information Systems—and quite honestly, I don't intend to become one. Bill Smith, whose paper deals with an actual GIS application in predictive modeling, is personally familiar with the system; so are Steve Hackenberger, Tim Kohler and others at this conference.

A Geographic Information System is an improved tool to store, update, analyze and display the following: (a) mapped relationships among and between resources; (b) quantity and quality descriptions of environmental information; and (c) the interrelationships between "a" and "b" (Engineering Staff n.d.). That is, GIS will merge computerized mapping and data base management capabilities to analyze and to provide a wide range of information about ground-locatable resources. Using currently available hardware (e.g., digitizer, graphics terminal, computer with CPU and storage, plotter) and software (a "public domain" program known as Map Overlay Statistical System, or MOSS), an advanced GIS could do the following:

(1) generate maps in a variety of formats and scales;

(2) perform complex, multi-variate analyses of any land area with the layers of environmental data;

(3) accept new information from many different sources (e.g., landsat imagery, high-altitude photography, on-the-ground field data). According to the people with whom I have spoken, the longer range possibilities of GIS are limited only be our own imaginations.

What will GIS be used for on the National Forests? Almost all of their resource management data and environmental information will be stored and utilized within the GIS. Current systems like TRI and R2MAP will lose their identity to GIS. Foresters, silviculturists, soil scientists and other resource specialists will all be utilizing GIS for data storage, map production, project design, resource planning, and decision-making. GIS should help make the job of archaeological modeling and survey strategy design easier and more accurate. It could, if available at the Ranger District level, perhaps even allow a field archaeologist or cultural resource technician to produce an inventory strategy map (based on the Forest's predictive model) of any timber sale area, almost at the touch of a button.

Among the many benefits to archaeologists of an ideal GIS are (1) its ability to analyze areas of widely-differing sizes, (2) its ability to handle easily new input; (3) its potentially user-friendly "attitude"; and (4) its *flexible* standardization throughout the Forest Service (and possibly other land-managing agencies as well). About the only serious drawback that comes to mind is the fact that GIS is not yet available. But, as mentioned previously, this fact may actually be a "plus."

Where is the Forest Service with its GIS planning at this moment? What should we do to ensure that our needs, as archaeologists, are considered and met by this new way of doing business? The Forst Service, primarily its Engineering and Management Systems sections at the Washington and Regional levels, has been engaged in an increasingly intensive GIS study for the past year or so. "Do we need a GIS?...Yes...Do we know what kind of GIS we want?...No, not yet, we don't know how many bells and whistles *our* system should have...Are we ready to commit funds to its development and installation?...Yes, almost ready." Essentially, that has been the agency's inner dialogue so far. Although an informal moratorium on the purchase of GIS equipment is now in effect, the Regions and, more significantly, the National Forests have been given annual GIS budget allocations beginning in Fiscal Year 1987. All Forests in the Pacific Northwest are scheduled to have at least "initial phase" GIS capability by FY 1988. (Ironically, the National Forests are only at this very moment installing and implementing their new nation-wide computer system, Forest Land Information Processing System, or FLIPS, and the Forest Service has recently learned that use of the currently available GIS software package (MOSS) will be severely limited by the FLIPS hardware; a new batch of expensive "GIS-dedicated" equipment will be necessary.) The agency's national GIS Task Force has recommended that the individual Regions be given considerable leeway in the design of their GIS. Definite goals and minimum standards for GIS thus likely will be met (and, we may hope, exceeded?) through the use of both broad guidelines from above and creativity from within. During the current fiscal year, the Pacific Northwest Region will embark on a comprehensive analysis of GIS costs-and benefits, workloads, alternative system configurations and, most importantly for us, the information requirements of the future system. By the fall of 1986, actual system procurement is scheduled to begin. This Region, together with the Alaska Region, will be pioneering the Forest Service's road to GIS. Because the actual form of the Geographic Information System is, at this time, dynamic and open, we have an opportunity to jump on the GIS wagon at the barnyard gate before it leaves us behind in the dust. The time is short. Do we simply wave at the wagon as it goes by and trust it to bring us what we really want when it returns? Or, continuing the metaphor, do we seize the opportunity to hop on, help steer the team, and see that it returns home with our own needed supplies? If the latter, it will require a definite, sustained commitment at both the Wahington and Regional levels, since that is where most of the action will be during the planning phase. To be successful, it will also take the enlightened advice and assistance from archaeologists who have experience with predictive modeling and GIS. There are a number of more specific actions that can be taken. Perhaps, during our dicussions this week, we can devote some time to the problems and opportunities of GIS, and come up with an (at least preliminary) action plan. One recommendation I will make here: if you have not yet begun doing so, start learning more about GIS. We need not all be experts, but we must have some familiarity with its functions and capabilities. As one GIS specialist recently stated,

> It is important...[to] acknowledge [just] how critical *informal, personal* relationships are in obtaining successful cooperation. When the real successes in the GIS field are examined, it will usually be found that they depended on a few individuals who got together and agreed on what to do, regardless of institutional barriers, perceived problems, or other obstacles (Dangermond n.d.:210, emphasis added).

I conclude this presentation with a couple more quotations. An East Coast archaeologist, recently speaking of GIS in the context of predictive modeling, gives us this caveat: "...1984 is upon us, and the Information Revolu-

tion will continue to spiral whether we approve of it or not. [Some] archaeologists may curse technological progress, but they will inevitably be overrun in its path" (Hasenstab 1983:28, quoted by permission of author). We cannot argue with that...1984 has come and gone; can "Brave New World" archaeology be far behind? So, let us, on our ever-accelerating journey of technological progress, not forget the goal of that path. Walter Fairservis, in his recent review of an introductory archaeology text, takes what seems to be an essentially positive position with regard to the computer revolution in the profession. However, Fairservis hopes that sometime soon "...one of us may lead the way to a 'new archaeology' less concerned with quantitative paradigms and more validly founded in the holistic study of the world's cultures." Otherwise, he warns that American archaeology could become:

> but an academic exercise, a delicious and absorbing way of indulging possibilities; but, at the last, a demonstration of futility given a gloss of scientific respectability and marvelous to computerize (Fairservis 1984:16).

NOTES

1. For the purpose of this paper, the variant systems will be included as part of the R2MAP discussion.

ACKNOWLEDGEMENTS

I thank the following people for sharing their knowledge of the three mapping systems discussed in this paper: Doug Kneeland (Management Systems section, Forest Service PNW Regional Office), Bryan Klenke (Timber Management section, Rogue River National Forest), and Marilynn Pantel (Land Management Planning section, Rogue River National Forest). Any technical blunders or errors of fact or omission are mine alone.

GEOGRAPHIC INFORMATION SYSTEMS (GIS): AN INNOVATIVE TOOL FOR RESOURCE MANAGEMENT

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Abstract

Working with a GIS designed by the Corps of Engineers construction engineering research laboratory, researchers at CWU are developing a predictive modeling program for the U.S. Army (Ft. Lewis and Yakima Firing Center installations). This paper will present examples from the YFC analysis, and comment on the potential impact of GIS technology on inventory, modeling, and survey research design.

At the 48th annual meeting of the Society for American Archaeology (Pittsburgh, 1983), Robert J. Hasenstab of the University of Massachusetts presented a paper entitled "The application of geographic information systems to the analysis of archaeological site distributions." In that paper Hasenstab suggests that the expression "GIS" will soon be a standard part of the archaeological vocabulary (1983:28). He concludes:

> GIS techniques can facilitate the development of sophisticated predictive models, by integrating existing site files with geographic data bases. Furthermore, they can operationalize both the interpretation of landscape patterns and the application of theoretical and anthropological models to real landscape surfaces. In sum, they can provide a practical benefit to cultural resource managers, and at the same time can offer an opportunity to academic researchers for the rigorous testing of scientific hypotheses (1983:29).

Perhaps even more quickly than Hasenstab anticipated, "GIS" has indeed become an archaeological "buzz-word". The forthcoming (1985) meeting of the Society for American Archaeology in Denver will feature a full-scale symposium on GIS research, chaired by Hasenstab and Kenneth Kvamme. Without doubt, here in the Northwest, as elsewhere, archaeological interest in GIS applications will expand dramatically in the near future.

My purpose in this paper is to discuss my own experience in working with one particular geographic information system, focusing mainly on problems of system development as seen by the system user, and commenting briefly on potential applications in predictive modeling and other aspects of resource management.

A geographic information system is a computer-based data processing system designed to incorporate large volumes of spatial data from a variety of sources, and to efficiently store, retrieve, manipulate, analyze, and display these data according to user-defined criteria. The GIS concept is not new; as early as 1963 the government of Canada began developing the CGIS (the Canada Geographic Information System), which remains one of the most comprehensive, elaborate GIS in existence today (Marble and Peuquet 1983:927). Until recently, however, such systems could only operate on very large, expensive mainframe computers, and were therefore highly centralized and generally beyond the reach of most potential users. Consequently, much of the potential impact of GIS technology has yet to be realized. As a result of the "microcomputer revolution", this situation is changing at a rate sometimes difficult to comprehend. Microcomputers have made sophisticated spreadsheet programs and inventory management systems available even to small businesses; the same technology now offers powerful GIS software for use by individual researchers, small universities, and the local or regional offices of government.

The GIS with which I am most familiar is being developed by an organization known as "CERL" (an acronym for the U.S. Army Corps of Engineers Construction Engineering Research Laboratory, located in Champaign, Illinois). CERL offers a variety of technical services in support of Army operations throughout the world. Several years ago CERL began developing a "pilot" GIS program for resource management purposes at Fort Hood, Texas (Goran et al. 1983). Since then, the CERL system has expanded into a GIS network that includes Fort McClellan, Alabama and Fort Lewis, Washington. Several other military bases are expected to join this system in the near future. Central Washington University became part of the CERL network last summer, when a prototype GIS was acquired in support of a predictive modeling effort undertaken by myself and my colleague Dr. James Chatters for the U.S. Army at Fort Lewis and the Yakima Firing Center.

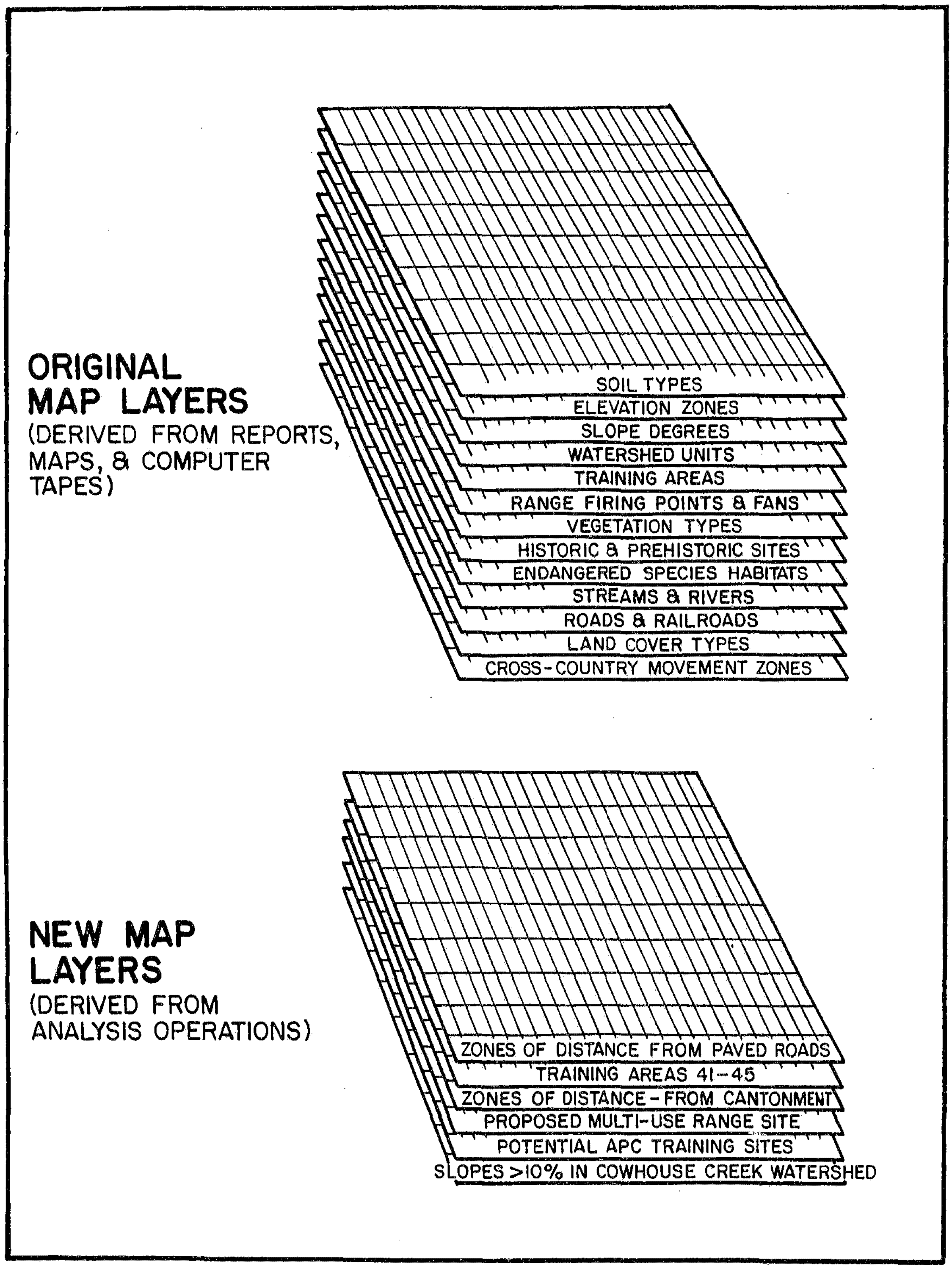

Figure 14: The data base.

The CERL/GIS is designed for use on computers equipped with the UNIX operating system (Karnigan and Pike 1984). UNIX (a trademark of Bell Laboratories) is a complex, comprehensive operating system originally developed at Bell Laboratories and later modified at the University of California, Berkeley. UNIX is written in the programming language known as "C" (Kernigan and Ritchie 1978). UNIX and C together provide an extremely powerful, flexible environment for system development. Both are highly transportable from one hardware configuration to another. Both are "terse", and appear somewhat "user-hostile" at first glance. Regarded as avant-garde items in the computer marketplace, UNIX and C are rapidly becoming available for a wide range of systems, from small micros to very large mainframe computers.

The hardware used by CERL/GIS comes from Massachusetts Computer Corporation (MASSCOMP). Our present configuration consists of a MASSCOMP 560 Color Graphics Workstation, with multi-user, multi-tasking capability. The system features a 2 megabyte 32 bit CPU, a 166 byte Winchester hard disk, a 19-inch color monitor with 832 x 600 pixel resolution, and various peripheral devices including a 1/4-inch tape drive, an inkjet color printer, and a dot-matrix printer. We hope to add several monochrome terminals, a digitizing tablet, and other hardware in the near future. Through a modem, our computer is linked by telephone to the CERL central computer in Illinois; from there we have access to the network of GIS installations at Fort Lewis, Fort Hood, and elsewhere.

Data sources for CERL/GIS include USGS quads, Army terrain analysis maps, LANDSAT images, aerial photographs, and a variety of maps resulting from specialized studies in range management, soils, archaeological surveys, and the like. Regardless of original scale, all maps are adjusted and indexed to a cellular grid system, in which each cell represents a land area of 50 x 50 meters. The cell grid is indexed to the UTM coordinate system. Input procedures include manual digitizing, videoscan,, and direct digital input from tape (e.g., LANDSAT or Defense Mapping Agency tapes; see Schowengerdt 1983).

These digital images can be conceptualized as a series of "map layers," which make up the original or permanent data base for a given study area (Figure 14; please note that Figures 14, 15, and 16 appeared initially in Goran and Wiggins 1983, and are used by permission of the authors). At present we are working with two study areas (Fort Lewis and the Yakima Firing Center), each consisting of 20 to 25 map layers. Each original map layer has associated with it a tabular array of data, providing statistics on the land area and percent of coverage in each data class, plus background information about data sources and classification categories.

Users gain access to the GIS through a high-resolution color graphics video display terminal, which also provides interactive control of the system. Operational procedures typically involve several steps: (1) identification of an area of interest within the data base; (2) selection of map layers and data classes of interest; (3) analysis and manipulation of the data layers; and (4) output of the resulting newly generated map layer together with its associated tabular data. Output normally goes to the video terminal, but can be redirected for hardcopy printing or file storage on disk or tape. At present the CERL/GIS incorporates about 25 system command functions, including:

- *display,* which allows the user to view any map layer; to modify the colors assigned to various data categories; to write labels, legends, scales, etc., onto the display; and to add linear features such as boundaries, roads, streams, or variable size grids, as well as point locations such as archaeological sites. A movable cross-hair, positioned by a joystick or a "mouse," allows the user to draw lines or polygons, define areas of interest, or read out the UTM coordinates of any point on the display. Additional functions (Figure 15) include:

- *window,* which includes functions allowing the user to define an area of interest within the data base;
- *overlay* functions, which allow the user to combine data from two map layers to create a new map layer. These new layers can be saved and then be recombined as often as desired;
- *distance-from* functions, enabling users to define areas within a certain specified distance zone from a given point, line, or area;
- *coincidence* functions, which produce cross-tabulations of the statistical data for any two map layers; and *report-generating* functions, which produce graphic or tabular results of the foregoing operations.

A hypothetical example (Figure 16) will serve to illustrate some typical GIS applications in resource management. Suppose that for a given management area (the island outlined in Figure 16, upper left), planners have established a GIS consisting of the necessary analytical programming together with a digital data base of multiple map layers. Suppose further that they wish to conduct a GIS inquiry session as part of the planning process with regard to a proposed land clearing project located on a peninsula in the eastern part of the management area. A

first step in GIS analysis would be to define a "window" of interest embracing the projcet area, to serve as the spatial frame for further study. Within this "window" the user can now view an enlarged portion of any or all of the map images in the data base; for example, a map showing proposed improvements in the project area (Figure 16, top center). Next, the user might examine a series of maps showing various conditions which would limit or constrain proposed development: for example, endangered species, steepness of slope, and location of historic/archaeological sites. From these separate map images, the user can create a new composite map (Figure 16, upper right), by means of the GIS "overlay" function. Next, the composite map can be combined with the map of proposed improvements, resulting in still another new map (Figure 16, lower left) showing areas of overlap or "conflict" which planners should avoid in preparing a revised plan of development (Figure 16, lower right). At any point during the GIS inquiry session, maps may be displayed on the video terminal, output to the color printer for hardcopy, and/or saved on disk or tape for future use. Likewise, for each existing or newly-created map, statistical tables can be generated to show area of coverage per class, percent of coverage per class, and coincidence of classes. Such tables can be displayed, printed, or saved to a disk file for further analysis. Time required for such a GIS inquiry session would vary from one system to another, and would depend in part on such factors as the total number of map layers to be analyzed and the amount of hardcopy to be produced. The CERL/GIS could readily accomodate such a typical inquiry session within a single afternoon.

Design and implementation of CERL/GIS was driven by the need to serve a variety of management requirements on military landholdings, including management of archaeological resources. Archaeological survey areas appear in the GIS simply as one of many map layers; site locations can be displayed as point elements marked by tiny asterisks. Data on the sites themselves are incorporated in a separate auxiliary CERL system known as ASIS (Archaeological Sites Information System). ASIS is a simple but very effective database management system which stores data in tabular form, and allows the user to conduct a variety of search-and-retrieval functions and to output the results in a variety of ways.

Some comments on ASIS will serve to indicate the kinds of problems we have encountered in using both ASIS and GIS, and in working with the system designers at CERL. When my colleague Chatters and I started working with the system last summer, we were surprised to learn that in our prototype system there was no direct interface or linkage between ASIS and GIS. Within ASIS we could conduct a search-and-retrieval operation to select a group of sites with characteristics of interest. We should have been able to input that list to GIS, create a new map layer, and begin studying relationships between site distribution and environmental context. After all, that is a basic step in archaeological analysis, of particular importance in predictive modeling applications.

After several months of consultation with the designers of CERL (whom we have found most creative and cooperative), we now have a version of ASIS better suited to our needs. We have been able to expand the number of data categories per site, and to tailor those categories to northwestern prehistory. We have an expanded list of ASIS user commands, allowing us to modify categories and values, and to add/update site records. Finally, we have a set of commands allowing us to interface ASIS and GIS.

At length we realized what should have been clear at the outset. The CERL system is not an off-the-shelf ready-to-run user-friendly menu-driven cellophane-wrapped package. It is a complex, powerful system, still being perfected, and subject to extensive field testing. We have, in fact, become a part of that field-testing effort. By doing so, we have gained an unusual opportunity to participate in the implementation of a highly innovative program. We are developing what we hope will prove to be a mutually beneficial relationship between CERL and Central Washington University.

If asked to give advice to anyone considering involvement with GIS technology, here are some suggestions I would offer:

1. Read everything you can find, of course. As yet there is no really extensive body of literature on GIS research or applications, but several books and articles are currently in preparation (e.g., Marble et al. 1985; Peuquet and Boyle 1985). The references given in this paper, while very incomplete, may serve as an initial guide.
2. Find a way to gain "hands-on" experience.[1] GIS procedures may seem simplistic, but in practice they are subtle, difficult to master, and limited in applicability only by the imagination of the user. Do not let yourself be easily discouraged. Review your own programmatic needs carefully to determine whether you really need a GIS. Sometimes a simpler technology may be more appropriate.
3. If you do need a GIS capability, make sure that the system you use is adequate to meet your needs. You may find, as we did, that your needs are better met by participating in system development than by opting for some apparently complete but fundamentally inadequate package.
4. In his book *Megatrends,* John Naisbitt remarks that "high technology" developments in modern society are often paralleled by the development of

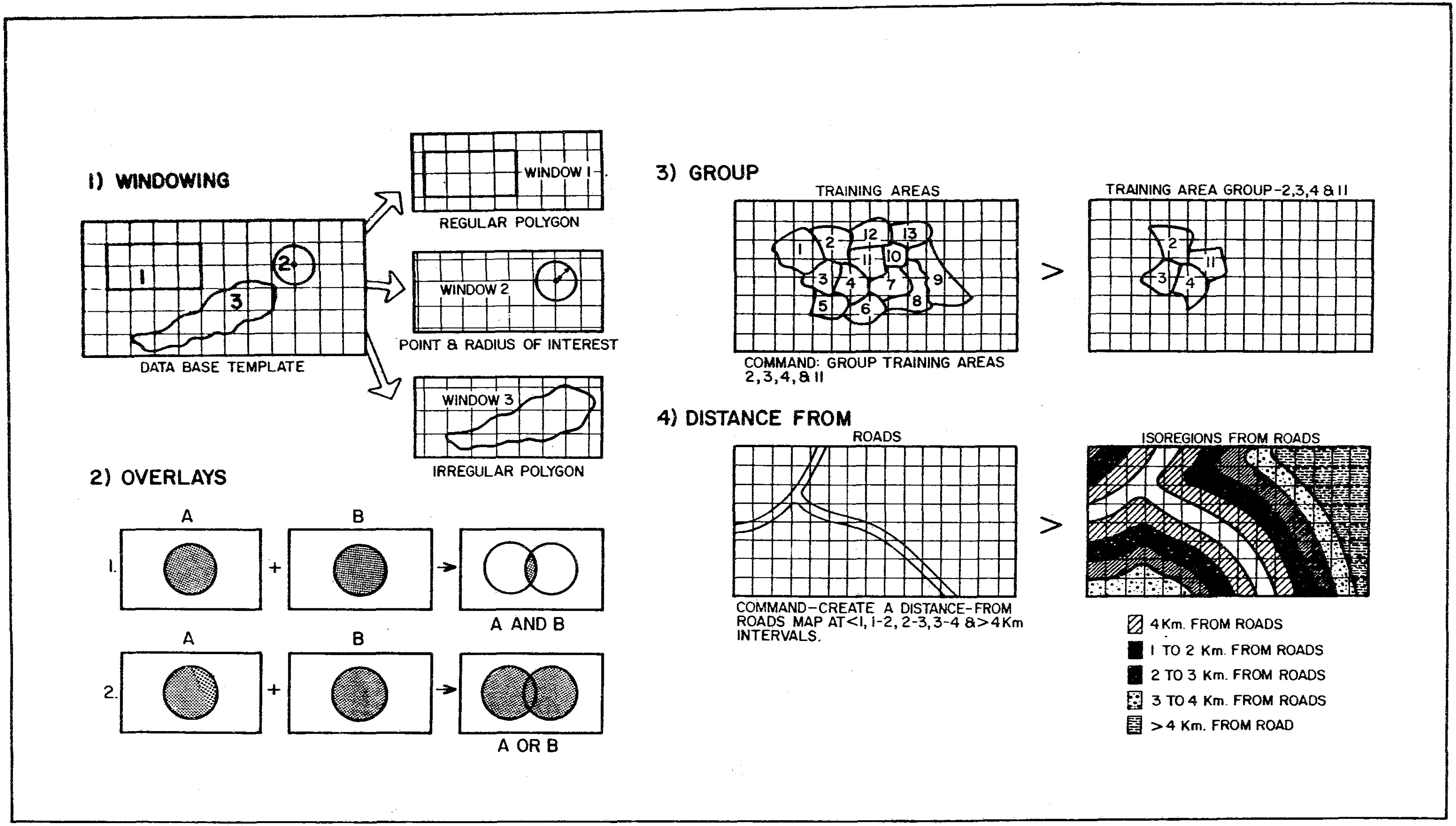

Figure 15: GIS analysis operations.

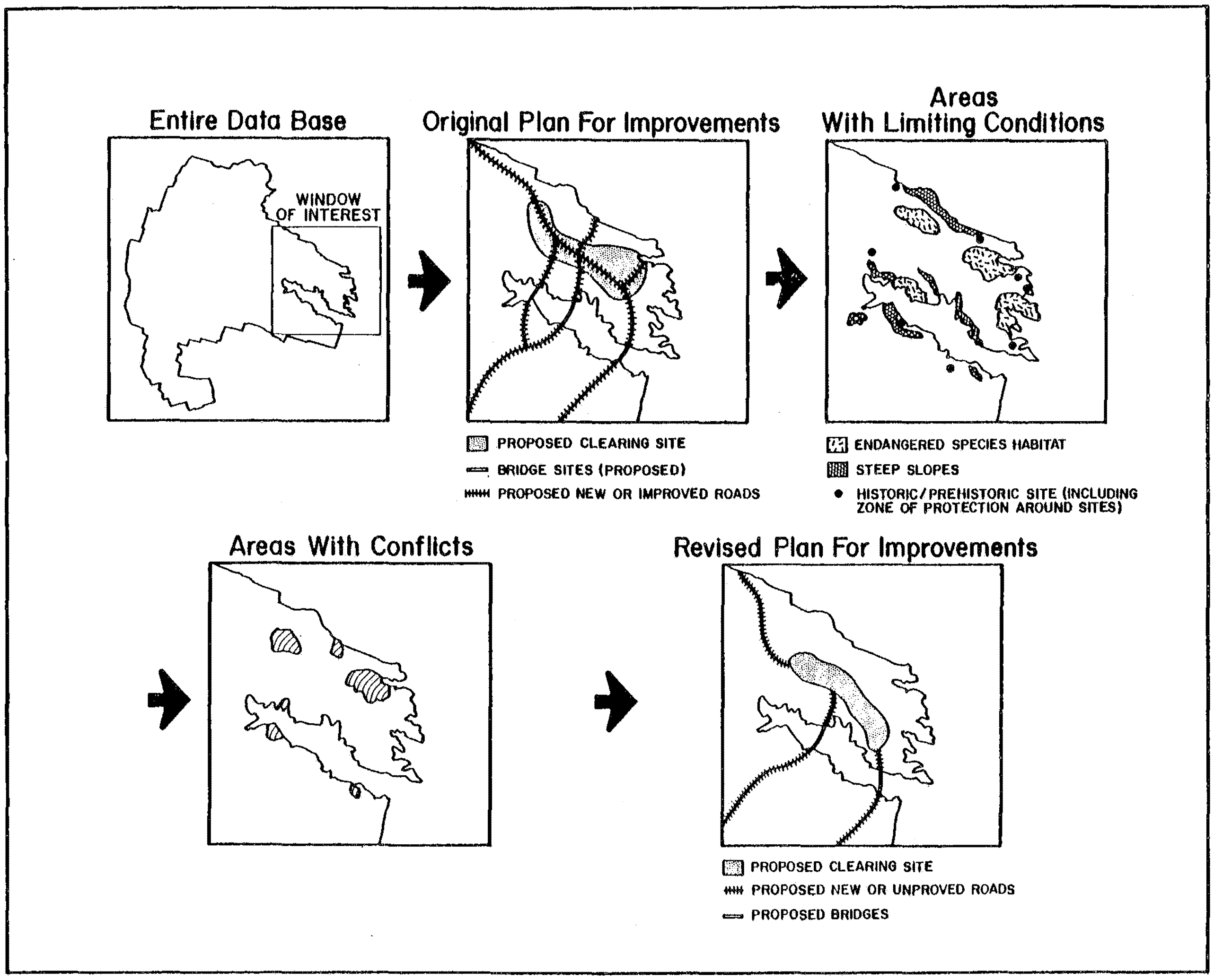

Figure 16: Impact assessment with GIS: an example.

flexible, innovative new "networks" of social relationship: computer "user's groups" are one example. Similar GIS-related networks are forming throughout the United States at present. It seems reasonable to suggest that those of us interested in GIS technology in the Northwest should consider an informal network or "user's group" for GIS information exchange.

NOTES

1. Central Washington University is establishing an administrative unit known as the Geographic Information Systems Laboratory, introducing a series of courses on GIS technology and applications, and developing several non-credit workshops, intended for agency management and staff personnel, to be offered at various times during the year. Contract services are also available; inquiries are welcome.

PROPOSED RESEARCH/

INVENTORY MODELS

DEVELOPING A RESEARCH DESIGN FOR THE OLYMPIC NATIONAL PARK

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Abstract

A central issue in Northwest Coast archaeology is whether or not the remaining archaeological record is a very biased sample resulting from destructive processes distinctive to coastal regions. Some archaeologists maintain that maritime adaptations have considerably greater time depth than the remaining archaeological record indicates and that evidence for early marine-oriented economics has largely been inundated. Proponents of this view maintain that the productivity of marine resources is such that, if available, they would have always been important in human subsistence. Another viewpoint is that marine resources were ignored for long periods and that the existing archaeological record documents increasing dietary dependence on marine resources resulting from population growth. A third viewpoint is similar to the second, but maintains that a record of increasing dependence upon seafoods is best understood as a response to environmental changes in post-glacial times. These three models are examined in a discussion of the role of problem orientation in a research design and site survey plan being developed for the Olympic National Park.

Project Background

The Office of Public Archaeology at the University of Washington is currently developing an archaeological research design for the Olympic National Park and a plan for dividing the Park into research units. These products are to provide a framework for archaeological research, compliance, and management of cultural resources for the Park Service. The research design and research units for the Park are aimed at providing an incremental, self-correcting, adaptive approach to management. Some of the ways we hope to build these qualities into the research design include (1) developing the best possible characterization of past and present environments of the region; (2) considering alternative archaeological models; and (3) applying the project-as-experiment concept. The last point identifies an approach in which information is collected in strategic ways to permit elimination or refinement of existing models or development of new ones.

The process of developing a research design will involve (1) development of a draft research design; (2) review and comment on the draft design; (3) revision of the design in light of reviewer comments; (4) a field test of the design; (5) revision of the design in the light of survey data; and (6) submission of a final research design.

A first-cut research design discussed in this paper focuses on the subject of aboriginal land use systems of the Olympic Peninsula. I use "land use" here as shorthand for subsistence/settlement systems. The concept of land use emphasizes the inseparability of subsistence and the spatial organization of subsistence over the landscape. An overall goal of this research design will be to provide a theoretical basis for understanding the structure of regional archaeological patterning. Although predictive modeling applications in cultural resource management often focus on site location, it seems clear that research and management requirements demand more than a working knowledge of where sites are likely to be located on the landscape. We must also know something about their content variability and why it occurs.

Land Use Systems on the Olympic Peninsula: A Theoretical Framework

There is remarkably little agreement among archaeologists about the process by which the historic maritime adaptations of the Northwest Coast developed. When winter villages first appeared, when storage of resources for delayed consumption initially occurred and when cultural systems like those described ethnographically first emerged in the archaeological record are but three examples of questions for which a number of dramatically different interpretations have been offered. Beyond these conflicting chronological issues, questions of causality are equally disputed. Some of the fundamental issues in contention in Northwest Coast archaeology are much the same as issues currently debated in the archaeology of many other coastal areas around the world. A central issue is whether the remaining archaeological record is a very biased sample resulting from destructive processes that occur in coastal regions. Some archaeologists maintain that maritime adaptations have considerably greater time depth than the archaeological record indicates and that evidence for early marine oriented economies has largely been inundated (cf.

Fladmark 1979). Proponents of this view maintain that the productivity of marine resources is such that, if available, they would have always been important in human subsistence. Another viewpoint is that marine resources were ignored for long periods and that the existing archaeological record documents increasing dietary dependence on marine resources resulting from population growth (cf. Cohen 1977; Osborn 1977; Schalk 1977; Yesner 1984). A third viewpoint is similar to the second but maintains that a record of increasing dependence upon seafoods was primarily a response to environmental changes in post-glacial times. These three viewpoints are represented in the models proposed for testing on this project and are discussed below.

Model 1: The Climatic Change Model

The first model relates directly to the three main environmental regimes that prevailed during the interval when humans are likely to have been present in this region. These climatic regimes include (1) a period between 14,000 and 8,000 BP when periglacial influences were present in the form of alpine glaciers in the Olympics; (2) a second interval between 8,000 and 3,000 BP (Hypsithermal) when dryer and warmer conditions prevailed; and (3) the last 3,000 years with climate much like today's (Heusser 1973). This model maintains that the major intervals of culture change were direct responses to climatically induced environmental change.

Given the differences in resources associated with each of these climatic regimes, this model predicts a sequence of three adaptations. The first is a big game hunting adaptation that would have prevailed prior to the wasting of alpine glaciers before 8,000 BP. This adaptation would have been characterized by primary dependence the year round upon herds of large herbivores, some of which are now extinct. With the onset of dry and warm conditions of the Hypsithermal, the diversity of large ungulates was reduced and deer and elk became the primary game resources. Carrying capacity of these species would have been quite high due to open forest conditions and milder winters. Mobile hunting adaptations that focused upon deer and elk are expected to have prevailed from about 8,000 to 3,000 BP. A major land use change is expected at 3,000 BP when cooler and wetter conditions resulted in a reduction in the overall productivity of land resources. This model predicts that land hunting would have been largely replaced by systematic and intensive marine resource use as the dominant subsistence strategy. Since no significant environmental changes have been documented for the last 3,000 years of the prehistoric record, this model predicts that settlement and subsistence systems basically like those of the historic period were established from the beginning of this interval.

Elements of this model can be found in many different studies (cf. Tuohy and Bryan 1959; Bryan 1963; Kidd 1964; Mitchell 1971; Grabert and Larson 1975; Thompson 1978; Wessen 1978).

Model 2: The Early Maritime Subsistence Model

The second model holds that the earliest human occupants of the Northwest Coast practiced a maritime economy but that fluctuations in sea level during the post-glacial period have obscured much of the archaeological evidence in coastal settings for periods prior to 5,000 BP (Fladmark 1974; 1979). According to this model, instability in river hydrology resulted in low salmon productivity prior to 5,000 BP. Stabilization of the land-sea interface at around 5,000 BP permitted the establishment of productive salmon runs in the rivers of the coast. Subsistence systems like those of the ethnographic period are postulated to have developed at about that time from systems that were already heavily oriented towards marine resource exploitation.

This model argues that marine-oriented economies have much greater time depth than that reflected in the surviving archaeological record. Archaeological evidence for marine resource use prior to 5,000 BP is believed either to be inundated and lost from the archaeological record or to be situated well above the modern shoreline on old beach terraces where detection is limited by dense vegetation. Although this particular model is primarily associated with Fladmark (1974; 1979), the possibility that evidence for early marine oriented subsistence systems has been lost or changing sea levels is a recurrent theme in much of the regional archaeological literature (c.f. Mitchell 1971; Grabert and Larson 1975; Thompson 1978; Wessen 1978).

Model 3: The Density-Dependent Intensification Model

The third model views population growth as the primary driving variable of culture change favoring increased marine orientation in subsistence. This model does not deny the importance of climatically induced environmental change but provides a mechanism for explaining cultural change during intervals of no known climatic change. Climatic changes in this model are reduced to a catalytic role in cultural change driven primarily by demographic conditions. This model maintains that major land use changes represented in the archaeological record of the Northwest Coast involved (1) a seasonal shift from hunting as the major economic pursuit the year around to use of fish and sea mammals during

spring and summer seasons, and subsequently, (2) a seasonal shift from hunting to reliance upon stored food as the primary winter season subsistence activity. These two changes would have required substantial adjustments in the spatial organization of settlement.

There are, then, three different land use strategies proposed by this model. The earliest one (14,000 BP-3,000 BP) is a land hunting system characterized by high mobility, immediate consumption (no food storage), minimal use of marine resources, and a "forager" type settlement system (see Binford 1980). This model proposes that at about 3,000 BP a second system developed in which marine resources (sea mammals, shellfish, marine and anadromous fish) replaced hunting as the main economic pursuit during the spring and summer seasons. This second system is also postulated to have "forager" characteristics. The third system proposed by this model is estimated to have developed at around 1,000 BP and involved the change from hunting to reliance upon stored fish as the primary winter season subsistence. The initial appearance of "collector" type (Binford 1980) land use systems is postulated at this time. This system is one in which there is heavy reliance upon delayed consumption (salmon in most areas), low residential mobility and high logistic mobility. Marine resources would be the mainstay in subsistence with hunting of land mammals a supplementary pursuit practiced mainly in the late fall and winter.

It is maintained that each of the three land use systems proposed by Model #3 is capable of supporting larger populations. This model is similar to Model #1 in identifying environmental change at the end of the Hypsithermal as a factor favoring increased use of marine resources at that time. The significant difference between these two models is that Model #3 postulates a later emergence of the ethnographic or "collector" type land use system in the absence of any known environmental change.

As presented here, this model is a composite of a number of studies that consider marine resource utilization, settlement variability, and food storage among hunter-gatherers (see Cohen 1977; Schalk 1977; Osborn 1977; Binford 1980; Testart 1982; Croes and Hackenberger 1984; Yesner 1984).

These alternative models can be utilized in developing expectations for the regional archaeological structure of the Olympic National Park. To formulate tests of the models it is necessary to segment the Park into research units. The following section proposes preliminary units that would be useful in performing such tests. For each of these units, there is a discussion of what each of the land use models predicts about the nature of archaeological remains in that unit.

Archaeological Expectations for Research/ Management Units

To operationalize the models presented above requires specification of expectations for the kinds of archaeological remains that should be associated with subsistence activities in
each of the research zones. One approach that can be used to do this is to employ the typology proposed by Binford (1980) and which distinguishes two fundamentally different settlement and subsistence strategies utilized by hunters and gatherers. A "forager" strategy is one which involves frequent residential moves, food procurement within the day-radius of residential camps, and minimal food storage. This strategy produces two basic site types: (1) "residential bases" occupied by all memebers of a band, and (2) "locations" where food resources are obtained. The forager strategy contrasts with the "collector" strategy in which residential mobility is much lower, task group procurement or "logistic mobility" is important, and dependence upon food storage is substantial. The "collector" strategy results in a greater variety of site types: (1) residential bases (villages), (2) locations, (3) "field camps" where logistic task groups stay while away from the base on procurement activities, (4) "stations" where resources are monitored, and (5) "caches" where resources obtained in bulk are stored.

Because virtually all Northwest Coast ethnographic groups practiced a "collector" type land use strategy, this typology may be particularly useful for identifying the archaeological appearance of such systems. With this approach for generating expectations for recognizing different land use systems in the archaeological record, a series of predictions for the three models discussed above can be advanced. The sections to follow consider the archaeological predictions of the three models for the various management zones proposed for the park.

The ideal research units for the purposes of the present study would be ones which accurately reflect those aspects of the environment most relevant to aboriginal subsistence. Those resources assumed to have changed most profoundly in subsistence through time would seem to deserve particular attention in efforts to partition a region into management zones. Division of the Park, therefore, might best be accomplished by identifying zones based upon a significant differences in the distribution of marine, anadromous fish and large game resources. With these considerations in mind, the Park can be segmented into zones which differ significantly with respect to these three resource classes. The proposed resource zones are illustrated in Figure 17. Each of these zones is discussed in the sections to follow along with archaeological expectations for each. Figure 18 summarizes the zonal archaeological expectations.

West Slope Olympic

The most salient characteristics of this zone are that it lies on the windward side of the Olympics where wet and mild climate produces floral and faunal contrasts to the east side of the Olympics. Included within this zone are all the drainages that enter the Pacific and the Strait of Juan de Fuca between and including the Quinault on the south and the western margin of the Elwha Basin on the north. The rivers of this zone have steep gradients in their upper reaches, but flow through coastal plains that are relatively broad and flat compared to the other drainages of the Olympic Peninsula. Elk are abundant in this zone and greatly outnumber the only other large native herbivore to this region—the black-tailed deer. Within the West Slope of the Peninsula, we distinguish three major environmental zones: Coastal, River Valley, and Montane.

West Slope Coastal Zone

This zone includes the entire 50 mile long strip of the Park that borders the Pacific Ocean. This is the only area of the Park that offers direct access to marine resources (sea mammals, shellfish, and saltwater finfish). Four of the largest rivers draining the west side of the Olympic Peninsula flow into the ocean within this zone and anadromous fish spawning habitat is relatively extensive compared to the East Slope drainages. In addition to the availability of important marine and riverine resources in this zone, historical information indicates that both summer and winter ranges of non-migratory elk occur in this zone as well. Owing to the heavy precipitation and rarity of forest fire in this zone, deer densities are very low (Taber 1980; Schwartz and Mitchell 1945).

Archaeological Expectations. Model #1 predicts few, if any, archaeological remains in the coastal zone before 8,000 BP. Given the faunal differences between windward and lee sides of mountains with alpine glaciers (Geist 1978) human occupation is expected to be confined largely to the east side of the Peninsula. With the onset of the Hypsithermal environmental regime, this model predicts that the Coastal Zone would be used for hunting of elk and deer; residential sites and locations associated with this activity should occur here. Given seasonal movement patterns of these species, it is likely that many such sites would relate to winter season hunting though hunting at other seasons might also be represented. After 3,000 BP, this model predicts that the full range of site types associated with ethnographic cultures of the area would be encountered in the coastal zone. These would include winter residential bases (villages), locations where marine and terrestrial resources were extracted, stations and caches.

Model #2 predicts that sites occupied prior to 5,000 BP and which were associated with marine resource exploitation will be inundated or located on higher ocean and river terraces in this zone. It also predicts that winter village residential sites spanning the last 5,000 years should be present at the modern sea-land interface. Locations, stations, and caches related to the harvesting of marine and terrestrial resources should occur in the coastal zone from 5,000 BP through the historic period.

Model #3 postulates a sequence of three qualitatively different subsistence/settlement systems. This model predicts that early hunters (12,000-8,000 BP) would have made little if any use of this zone. Between 8,000 and 3,000 BP, this zone would have been used by mobile hunting bands—especially during winter. Archaeological remains associated with this use would be briefly occupied winter residential bases and resource extractive locations (e.g. kill/butcher sites). With the postulated subsistence/settlement shift from hunting of land mammals to use of marine resources during spring and summer seasons at about 3,000 BP, the first intensive use of this zone is expected. After 1,500 BP, with the appearance of intensive food storage, winter sedentism, and central base "collector" type settlement systems, archaeological remains in this zone will be mainly winter residential villages and special purpose resource procurement sites occupied during the spring and summer.

West Slope River Valleys

Included within this zone are all west slope valleys within the Park that lie below the 600 m (2,500 foot) elevational contour. Two important considerations stand behind the selection of this elevational boundary distinguishing River Valley and Montane Zones. The first is that this is the elevation above which most of the annual precipitation falls as snow. Deep snow above this elevation provides a substantial seasonal barrier for winter use by either humans or large game. Within this zone most precipitation falls as rain and it does so in prodigious amounts. This boundary, then, separates areas used by game during the winter and summer. Migratory elk winter ranges occur just below the snowline at elevations between 450 and 600 meters (1475-1968 feet) (Taber 1980; Schwartz and Mitchell 1945). Extensive winter ranges for resident or non-migratory elk also occur within this zone at slightly lower elevations than those of the migratory herds. It is estimated that 85% of the total elk on the Olympic Peninsula occurred in the West Slope river valleys in historic times and this zone coincides closely with the mapped historical distributions of migratory elk winter ranges (Schwartz and Mitchell 1945:305). The second reason for recognizing this particular division line is that it roughly demarcates the upstream limit for salmon

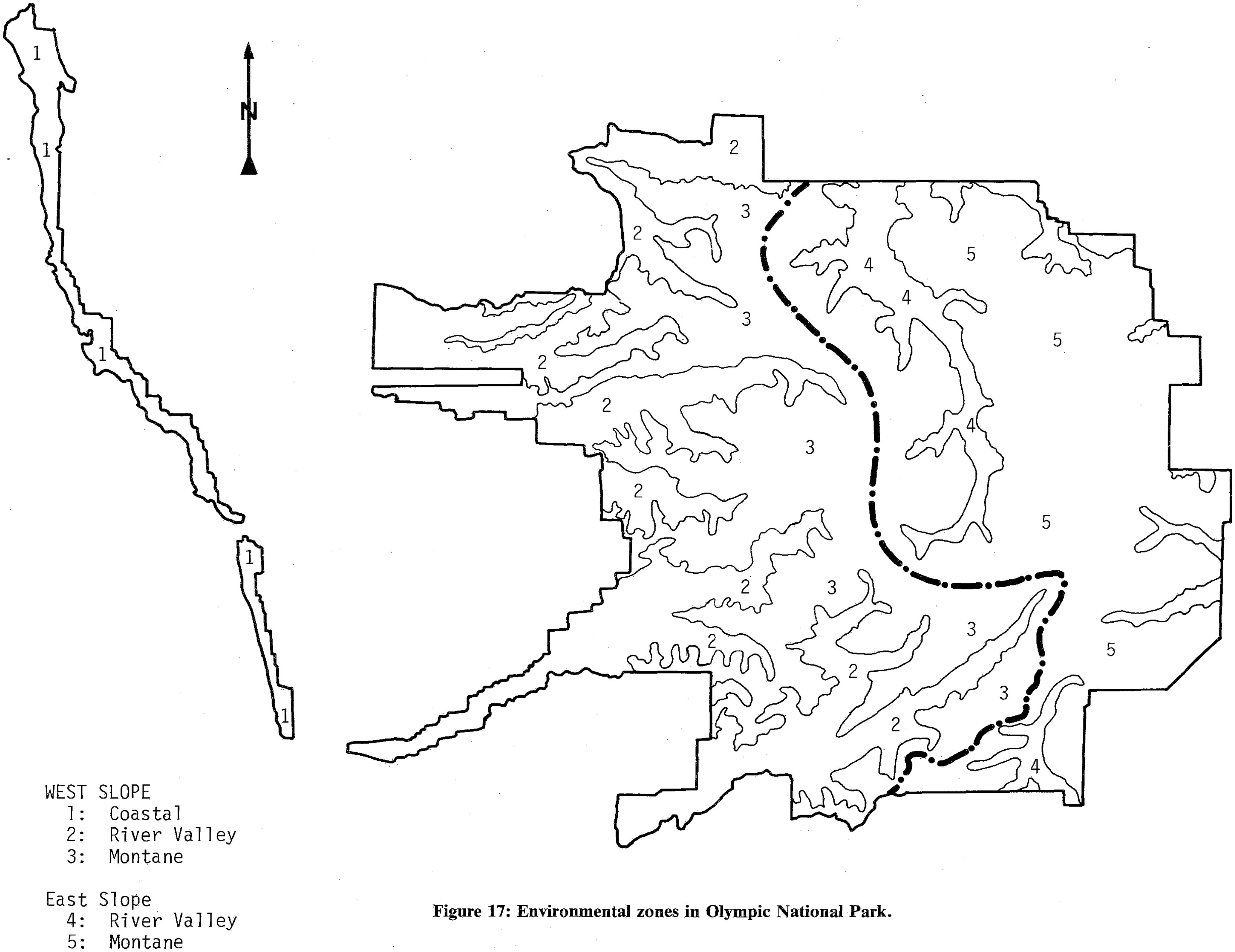

Figure 17: Environmental zones in Olympic National Park.

migration in the drainages of the West Slope. Coho, spring and summer chinook migrated into all major drainages within this zone; chum and sockeye run well into this zone in the Queets and Quinault Rivers (Phinney and Buckwell 1975). There is, on the other hand, no evidence that salmon utilized areas above the 2,500 foot contour.

Archaeological Expectations. Model #1 predicts that there will be little, if any, archaeological record predating 8,000 BP in this zone. During the Hypsithermal (8,000-3,000 BP), this model predicts that use of this zone would include residential bases and locations resulting from hunting of deer and elk. Since game use this zone primarily as winter range, most archaeological remains are expected to reflect winter through spring seasons of occupation. Because at least some resident game populatins occur in this zone, it is possible that some sites in this zone may result from occupations at any season of the year. With a postulated emergence of ethnographic systems at about 3,000 BP, this zone should contain the various types of sites produced by "collector" type systems—winter residential bases along lower portions of productive salmon streams, field camps, resource extractive locations (e.g. fishing camps, game kill sites), game monitoring stations, and food caches.

Archaeological expectations of Model #2 regarding seasonal use patterns in non-coastal settings prior to 5,000 BP are not clear. This model would probably imply that any archaeological occurrences here would be residential bases and locations associated with winter hunting of large land mammals. After 5,000 BP, this model predicts that archaeological remains should be virtually indentical with those generated by the ethnographic land use systems. These should include riverine fishing camps occupied from spring through fall, riverine villages along productive reaches of salmon spawning habitat, and winter season special purpose hunting camps situated in areas of winter range for big game.

Model #3 predicts that this zone will have few, if any, archaeological remains older than 8,000 years. Two kinds of sites should be represented throughout the interval 8,000 to 3,000 BP—fall, winter and spring residential sites and locations where game is killed and/or butchered. Because some resident elk and deer are present in this zone the year around, some hunting may have occurred here at all seasons of the year during this interval. Between 3,000 and 1,000 BP, however, a proposed change to spring/summer/fall use of marine resources would suggest that any sites in this zone will be mostly residential bases and locations generated during winter hunting activities. After 1,000 BP, this model predicts that this zone will contain all the kinds of sites generated by "collector" settlement systems. These would include winter villages along lower reaches of productive salmon streams, "locations" where game, fish, or other resources were extracted, "field camps" where specialized task groups camped, "stations" such as winter game monitoring sites, and possibly "caches" where bulk resources such as elk meat would have been temporarily stored for later transport to a village site. Most of these sites should relate to fall and winter procurement activities.

West Slope Montane

This zone includes all the forests, parklands and meadows that occur above 2,500 feet elevation. During the winter there is negligible use of this zone by elk or deer due to the depth of snow accumulation. In the spring, migratory elk follow the snow melt up slope into this zone where they remain throughout the summer. The subalpine parklands near the upper edge of the forest appear to be particularly important areas of congregation for large numbers of elk that may come together from different river valleys. Much of this zone is snowfree for a brief interval of about two months in August and September. Because mountains of the western Olympics are lower than those of the eastern Olympics, parklands and meadows within this zone are very limited in extent compared to its eastern counterpart (Kuramota and Bliss 1970). This zone is characterized by limited numbers of deer and lies above areas reached by salmon.

Archaeological Expectations. Model #1 predicts that there will be no archaeological record in this zone prior to 8,000 BP. Residential bases and locations would result from summer and fall season huntng of elk and deer during the interval 8-3,000 BP. After 3,000 BP, this model predicts no significant use of this zone. The game resources available here could be more effectively exploited by hunting task groups operating out of winter villages and concentrating on winter game ranges at lower elevations.

Model #2 again makes no explicit predictions regarding seasonal patterns of upland resource utilization. Assuming that prior to 5,000 BP we are dealing with maritime oriented adaptations, summer and fall are seasons during which we would expect to find people at or near the coast. The lowest daylight tides for shellfish exploitation occur during these seasons, halibut move shoreward and sea mammals attain their greatest yearly abundance. All major salmonid runs occur during these seasons as well. Utilization of marine resources during the season of their greatest abundance, therefore, would provide a scheduling conflict with use of this zone. This zone is only accessible for humans, elk or deer during the warm season of the year and a logical interpretation of this model model is that it would not have been used by mari-

WEST SLOPE ENVIRONMENTAL ZONES				EAST SLOPE ENVIRONMENTAL ZONES	
	Coastal	River Valleys	Montane	River Valleys	Montane
MODEL #1	All "collector" site types	All "collector" site types, including winter villages along lower river valleys	Little or no use	All "collector" site types except winter villages (fall, winter)	Little or no use
3000					
	Residential bases and locations	Residential bases and locations (mostly winter occupations)	Residential bases and locations (summer only)	Residential bases and locations (winter)	Residential bases and locations (summer, fall)
8000					
	Little, if any, use	Little or no use	Little or no use	Residential bases and locations	Residential bases and locations (summer?)
MODEL #2	All "collector" site types	All "collector" site types, including riverine winter villages	Little or no use	All "collector" site types except winter villages	Little or no use
5000					
	Residential bases and locations on terraces 5000 BP	Residential bases and locations (summer, winter?)	Little or no use	Residential bases and locations (winter)	Little or no use
MODEL #3	All "collector" site types	All "collector" site types	Little or no use	All "collector" site types except winter villages	Little or no use
1000					
	Residential bases and locations (summer and winter)	Residential bases and locations	Little or no use	Residential bases and locations (mostly winter)	Little or no use
3000					
	Residential bases and locations	Residential bases and locations (all seasons?)	Residential bases and locations (summer only)	Residential bases and locations (all seasons)	Residential bases and locations (summer)
8000					
	Little, if any, use	Little, if any, use	Little or no use	Residential bases and locations	Residential bases and locations (summer)

Figure 18: Archaeological expectations for zonal distributions of settlement types.

time oriented adaptations present before 5,000 BP. After 5,000 BP, this model predicts minimal use of this zone by "collector" type land use systems. The elk and deer present seasonally here could be more effectively exploited by "collector" type land use systems in the late fall and winter when these animals are driven into the river valleys below the snowline (see Smith 1964). During these seasons they could be exploited when they were much closer to river valley or coastal villages by task groups operating out of those villages. By focusing the hunting of elk and deer on their winter ranges, fresh meat would be an important supplement to stored foods during the season of greatest scarcity. For these reasons, this model leads to the expectation that archaeological remains more recent than 5,000 BP will also be absent from this zone.

Model #3 makes the same predictions for this zone as Model #1. That is, all archaeological remains from this zone are expected to be residential bases and locations occupied between 8,000 and 3,000 BP. After 3,000 BP exploitation of elk and deer would have occurred on winter ranges that occur below 2,500 feet. There should be, therefore, minimal archaeological record after 3,000 BP in this zone.

East Slope Olympics

Climatic effects on the lee side of the Olympics contribute to less precipitation and forest types of quite different composition than occur on the West Slope. The East Slope valleys drop precipitously from the mountains to the Hood Canal and there is minimal coastal plain. This side of the Olympics is subject to severe forest fires and virtually the entire East Slope was burned between 1650 and 1700 (Taber 1980). This zone dramatically differs from its west side counterpart with respect to game, salmon, and marine resources.

Black-tailed deer populations of the Olympic Peninsula vary negatively with precipitation while Roosevelt elk vary positively (Taber 1980). The result of reduced precipitation in this zone is that deer greatly outnumber elk, a reversal of the pattern described for the Western Slope. Historical evidence indicates that elk herds were very small (Schwartz and Mitchell 1945), their habitat being rather poor on this side of the Olympics (Taber 1980). Due to the virtual absence of a coastal plain along Hood Canal, there are very restricted areas below 2,500 feet elevation that are suitable as winter range for big game.

Because of the steep gradients of the East Slope drainages, anadromous fish are blocked from access to the Park by numerous waterfalls and cascades. All spawning populations in the rivers of this zone are confined to lower reaches of streams and do not extend into the Park. Within the East Slope Olympics, we distinguish two major environmental zones within the Park: East Slope River Valleys and East Slope Montane.

East Slope River Valleys

The upper limit to this zone and its boundary with the East Slope Montane zone is set at the 2,500' elevational contour for reasons that were presented in the discussion of the West Slope counterparts. Composition of the forest in this unit is quite different than that on the west slope due to rainshadow effects and the importance of wildfire. These conditions result in a reversal in the proportions of elk and deer from those occurring in west slope forests at comparable elevations. Small areas of elk winter range occur in the lower reaches of major drainages of this zone (Dosewallips, Duckabush, Hamma Hamma, and Skokomish) but these lie outside the borders of the Park. Other valleys draining into Hood Canal support very small elk populations with their winter ranges entirely outside the Park boundaries. In contrast to the West Slope where both migratory and non-migratory elk herds occur, most are migratory in this zone. Anadromous fish resources are absent or insignificant within this portion of the Park.

Archaeological Expectations. According to Model #1, this zone has potential for containing sites occupied prior to 8,000 BP. Such sites would either be residential bases or locations. Given present information on yearly game distributions and behavior in periglacial environments, seasonal use patterns of this zone for this early period can not be predicted. Between 8,000 and 3,000 BP, this model predicts that use of the zone will be primarily for winter season hunting of deer and elk. Fall, winter, and spring residential bases and locations are the two kinds of sites expected in this zone during the Hypsithermal. After 3,000 BP, Model #1 predicts that this zone will contain all of the site types of the collector type settlement system except winter villages. Since salmon are not available in those portions of this zone that lie within the Park and because much of the game here tends to migrate upslope in the spring, most sites should be related to fall/winter hunting of deer and elk. These would include field camps, locations, stations, and caches.

Model #2 predictions for this zone are similar to those it makes for West Slope River Valleys except that no fishing-related remains are expected.

Model #3 predicts that archaeological remains in this zone will differ from those found in West Slope River Valleys in three ways. Prior to 8,000 BP when this zone would have been influenced by alpine glaciers in the

mountains to the west, this zone may have been used by big-game hunters. Current information on game species present, their distribution and behavior during that period are insufficient to predict season of use in this zone but settlement systems with "forager" characteristics are expected. Archaeological remains, therefore, would either be residential bases or locations. The second contrast is that this zone should contain no archaeological remains associated with salmonid fishing activities. This would imply that sites less than 1,000 years old here should mainly be related to the logistic procurement of deer or elk by task groups operating out of residential bases located below this zone. The third contrast is that site location and assemblage content in this zone may differ in subtle ways from West Slope River Valleys owing to the fact that deer rather than elk are likely to have been the primary game species hunted on this side of the Olympics.

East Slope Montane

This zone includes all East Slope areas above the 2,500' contour line. It is characterized as summer range for deer and elk. Most of the parklands at the upper margin of the subalpine forest and the subalpine meadows within the Park occur within this zone and are apparently caused by fire (Kuramota and Bliss 1970). Alpine communities between 5,000 and 7,000 feet elevation are also heavily used by game for a brief interval in the late summer when snow disappears.

Archaeological Expectations. According to Model #1, this zone is expected to contain the archaeological expression of summer and fall hunting activities between 8,000 and 3,000 BP. Since the model envisions a forager type land use system for this interval, archaeological remains should mainly be residential bases or locations. The model postulates the emergence of the ethnographic collector type system at 3,000 BP, after which this zone would see no further use because game exploitation strategies would be focused on winter and spring ranges at lower elevations.

Model #2 predicts that this zone will have minimal use prior to 5,000 BP because effective exploitation of marine resources would provide a scheduling conflict with summer/fall use of montane areas. With the postulated emergence of ethnographic land use systems after 5,000 BP, this zone would still see minimal use. The postulated change to a "collector" type settlement system after 5,000 BP would imply that the deer and elk present in this zone in the summer and early fall would have been more effectively exploited after they moved down into East Slope river valleys in the late fall and winter. In short, this model leads to the expectation that prehistoric archaeological remains of any age should be lacking in this zone.

Model #3 predicts that this zone will contain summer/fall residential bases and locations dating between 8,000 BP and 3,000 BP. A proposed shift to exploitation of marine resources during the summer and fall seasons around 3,000 BP will result in the absence of archaeological remains after that time.

Conclusions

Archaeological surveys in the densely forested areas of the Olympic Peninsula over the past several years have met with remarkably poor success in the identification of archaeological remains. One is led to the inescapable conclusion that either the survey methods in use today are ineffective for archaeological inventory or this region is characterized by extraordinarily low densities of remains. It is clear from the results of numerous archaeological surveys in the forests of the Peninsula that current survey procedures have little potential to produce new archaeological information.

In view of these circumstances, the survey procedures used presently should be reevaluated. Instead of thinking of survey as a means for developing an inventory of archaeological sites, a more fruitful approach may be to concentrate on those zones which offer the greatest potential for critical tests of alternative models of land use. Obviously, the results of survey in one zone should enhance knowledge of the archaeological resources in other zones. The selection of survey areas in the Park for field testing this research design should be done so that the strongest possible tests of the land use models can be achieved in the most cost-effective manner possible. We hope to acquire archaeological information that will increase capacity for prediction of the kinds of remains likely to be encountered in specific areas of the Park. Predictive power can be developed most efficiently by identifying the most rigorous tests possible with the least survey. Given the high relief landscape over much of this region and the probable importance of various spatially concentrated resources, the degree of locational predictability eventually attained may be quite high.

It should be clear that some zones offer greater potential to discriminate between various land use models with the kinds of data recovered in survey. A particularly exciting implication of the preliminary arguments that have been presented is that inland zones of the Park may provide better potential for testing the three models than the Coastal Zone. Depending on results of the first year's efforts, it might be argued that the greatest amount of information can be obtained by concentrating survey activities within one or two zones where the model predictions are most conflicting. Assuming that the survey is

designed in at least two phases, results of work in survey of one zone should permit a disconfirmation of one or more of the models. Finding archaeological remains in the West Slope Montane zone, for example, would seriously weaken Model #2. This result would encourage selection of a second zone for further survey where the predictions of models #1 and #3 are most conflicting.

The major result of this project will be a research design that has been reviewed, revised, field tested in a phased survey, and further adjusted and refined in the light of survey results. This design can easily accomodate other land use models that have not been considered. Formulation of the design with alternative models minimizes the risk of management that is guided by a single self-fulfilling viewpoint and maximizes the potential for identifying resources of unusual scientific significance. In preliminary form, this design already provides a means for prioritizing research zones of the Park in terms of their potential to shed new light on models of prehistoric land use. This capability should be subject to constant strengthening long after this project is completed. Small compliance related projects within the Park will have an in-place framework for investigations so that they provide ongoing opportunities to contribute to regional research.

The research units will have benefited from the same adaptive process. The rationale for distinguishing them is founded on important differences in food resource distributions within the Park. Refinements of these units, where necessary, will most likely involve further subdivisions to accomodate finer-grained environmental distinctions.

This project should also provide information of interest well beyond the Northwest regarding the evolution of maritime adaptations. It is pertinent in this regard to note that the research design presented here offers a means for overcoming the "hidden data" problem that has plagued coastal archaeology. It does so by establishing a framework for testing models pertaining to marine resource use with data from non-coastal settings.

Finally, there are two obvious and important issues that I have not addressed here but which will be given serious consideration as this work progresses. The first is quite familiar to the participants of this conference and has to do with the development of methods and techniques for effectively locating archaeological sites in densely forested settings. I anticipate that we will be in a much better position to deal with this very significant methodological problem once we have made explicit *what* we are looking for and *where* we expect it to be. The second issue has to do with how we move from the coarse-grained environmental strata discussed in this paper to predicting the presence/absence of archaeological remains at specific locations or on various landforms. I have only discussed site location in very broad terms not particularly satisfying to those who would like to use environmental variables to predict the locations of archaeological remains. I see the development of models which have such predictive capability as the next step in the process of formulating a research design. In other words, the next step will consider how elk behavior would condition site location within the montane zone or how shellfish beds would influence site positioning along the coastal zone.

RESEARCH DESIGN FOR THE WALLOWA PREHISTORY AND PALEOENVIRONMENT PROJECT

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Abstract

The Wallowa Mountains are a 3,200 km² radially drained alpine outlier of the northern Rockies in northeastern Oregon. Located at 45 N between the Plateau and Basin provinces, the area offers many opportunities for controlled comparisons of cultural adaptation and environmental change. A research design is outlined for long-term comparative study of forager and pastoral nomad land use across steppe/forest and canyon/plateau/montane gradients.

Introduction

The Center for Northwest Anthropology at Washington State University plans to conduct archaeological and paleoenvironmental investigations in the Imnaha basin of the Wallowa Mountains in northestern Oregon in the summers of 1985 and 1986. The goals of the project are to study changes between late prehistoric forager and early historic horse nomad land use patterns across steppe and subalpine forest gradients by means of a series of two-case controlled comparisons. The first stage, described here, focuses on the Imnaha basin in the Wallowa-Whitman National Forest, where late prehistoric and protohistoric cultural adaptions and paleoenvironmental records from the steppe and playa area of Clear Lake Ridge, in the lower basin, will be contrasted with the subalpine forest and glacial lake environment of the Imnaha Divide, in the upper basin.

Specifically, we seek an understanding of high country (above 4,500 feet or 1,372 m) land use during the Snake River Period, 500 BC-AD 1700, and the Ethnographic Period, AD 1700-1900. It has been argued that late prehistoric land use in the Northern Rockies intensified as the regional population grew (Thoms and Schalk 1984). Evidence for intensification includes changes in settlement pattern, and the appearance of what may be anthropogenic fire regimes in the region after 2,000 BP (Mehringer 1977; Hemphill 1983; Smith 1983). However, Nez Perce ethnographic data for the project area are ambiguous concerning high country intensification.

For example, Schwede's (1970) study of seasonal camp distributions showed 89 percent (n=121) located below 4,500 feet on second order or higher stream confluences, while Marshall's (1977) account of seasonal hunting behavior locates camps below ridge crests at the heads of first order streams, and therefore generally above 4,500 feet. Neither study evaluates the role of horse pasturage as a determinant of Ethnographic Period land use patterns, and there are no data on the fire history on the project area before 1839 (Drury 1958:271,173).

Both Clear Lake Ridge and the Imnaha Divide area are managed by the USDA-Forest Service, and the research proposed here has been designed in consultation with the Wallowa-Whitman National Forest Archaeologist, the Wallowa Valley Ranger District Archaeologist, and the Region 6 (Pacific Northwest) Archaeologist. The Clear Lake Ridge area is managed for multiple use while the Imnaha Divide area is part of the Eagle Cap Wilderness Area, where historic disturbance in general, and timber harvesting impacts (Wildesen 1982) in particular, are minimal. The two sites to be excavated are part of a scheduled land exchange between the Nature Conservancy and the Forest Service involving Downey Playa. After testing both sites in 1983, the Forest Archaeologist determined that mitigation by data recovery was the appropriate management tactic because of their information potential for the Forest as a whole.

Fieldwork will include excavations at sites 35WA615 and 35WA616 at Clear Lake Ridge in 1985, and intensive survey in the Imnaha Divide area in 1986. Test excavations show that the Clear Lake Ridge sites date to the early (35WA615) and late (35WA616) Snake River Period. Both sites have excellent faunal and botanical (including wood charcoal) preservation, intact fire cracked rock features, and large, functionally diverse chipped stone assemblages that are derived from geographically discrete toolstone sources. Laboratory studies will include analyses and interpretation of assemblage patterning in artifacts, features, faunal and plant remains, and C14 dates from the Clear Lake Ridge excavations. These data sets will then be used to interpret the results of the 1986 survey. Independent paleoenvironmental records for Clear Lake Ridge and Imnaha Divide will be acquired by coring Downey Playa in the lower basin

steppe, and Duck Lake in the upper basin subalpine forest. The analysis of cores will include close-interval pollen and macrofossil analyses and dating by radiocarbon and tephra.

The project can be justified from three perspectives. First, as discussed above, prehistoric cultural occupation of the Wallowas is poorly known, and the timing and nature of aboriginal land use above the ethnographic "ceiling contour" of 4,500 feet await documentation. Variability between "lithic scatters" is documented in the forest inventory and timber sale literature (Rice and Bilderback 1977; Wright 1977; Friedman 1978; Anslinger 1980; Walker 1980; Nisbet 1982), but interpretations have been frustrated by lack of control assemblages in the uplands that have organic preservation and site structure suitable for comparison. To date, excavations have focused on large but functionally overspecified quarry and lithic workshop sites (Nisbet and Drake 1982; Womack n.d.). These reports have produced important data on the structure, pattern, and scale of toolstone geography within the Forest, but their results have yet to be built into a regional analysis of land use and paleoeconomy.

Second, Holocene paleoenvironments of the Wallowas are presently understood mainly from Neoglacial advances in the Eagle Cap that are dated only relatively (Kiver 1974; Allen 1975). The analysis and dating of lake deposit pollen and charcoal stratigraphy will help fill in gaps in existing transects between the Northern Rockies (Mehringer et al. 1977) and Great Basin (Mehringer in press; Aikens 1984). Third, the findings of the project will aid cultural and natural resource managers in the Forest Service with their predictive modeling and multiple use planning activities. Research results should inform on a range of concerns including the nature of late prehistoric and protohistoric settlement and subsistence, and the changing composition of forest vegetation as influenced by climate, fire, and grazing.

Research Design

Study Area

Geographically, structurally, and ecologically, the Wallowa Mountains are a 3,200 km^2 alpine outlier of the Northern Rocky Mountains (Price 1978; Arno and Hammerly 1984), separated from the main cordillera on the east by Hells Canyon gorge of the Snake River. To the south and west are the subalpine Blue Mountains, separating the southern Columbia Basin from the northern Great Basin (Figure 19). Structurally, the Wallowas are formed from a granodioritic batholith of Cretaceous age that is intruded into Permian and Triassic metasedimentaries and metavolcanics, and surrounded and partially capped by Columbia River basalts of Miocene age. Fifteen peaks greater than 9,000 feet (2,432 m) elevation occur within the 2,048 km^2 Wallowa dome. Three episodes of Holocene alpine glaciation are documented in the Eagle Cap area (Kiver 1974). The early Holocene Glacial Lake advance predates 6,600 BP. A middle Neoglacial Prospect Lake advance may correlate with the Audobon stade in the Front Range of the Southern Rockies, and is dated at 1,900-950 BP. The late Neoglacial Eagle Cap advance postdates 600 BP.

Drainage out of the central Wallowa dome is radial, and includes the upper basins of Wallowa, Imnaha, Powder, and Grand Ronde Rivers, all tributary to the Snake. Relief is locally abrupt. For example, the Imnaha drops 6,400 feet (1,950 m) in less than 90 km between its headwaters at Little Crater Lake and its mouth. However, benches and level parks in the upper reaches contain many alpine lakes, bogs, and wet meadows, and relatively gentle slopes occur between divides, for example, between Big Sheep and Gumboot Creeks. Timberline extends to about 7,500 feet (2,286 m) in the upper basin. Soils are generally absent above 8,000 feet (2,438 m) and are often absent locally for several tens or hundreds of meters below this elevation (Ross 1938:10). In the ridge and canyon rainshadowed country of the lower basin, the vegetation is predominantly bunchgrass steppe, with riparian treelines paralleling the drainage and isolated ponderosa parks on north facing benches.

The study area, at about 45 degrees north latitude, has a rigorously seasonal climate, with a mean annual temperature of 6.1 degrees C and mean annual precipitation of 34.8 cm. Temperature extremes range from -38 degrees to 39 degrees C. Precipitation occurs as snowfall for about half the year, between October and April (Larson 1981:98). The surface of the Imnaha Divide area is covered with at least 20 cm of snow from late fall through late spring.

Historic Land Use: The Impact of the Horse

The arrival and rapid multiplication of horses after AD 1700 has influenced both the environment of the study area and the ways in which anthropologists look at its recent prehistory. For example, Clear Lake Ridge may have served as a Nez Perce summer pasture, given the lakes located along the summit, and its proximity to a large village site at the confluence of Sheep Creek and Imnaha River. Grazing and trampling disturbance of the vegetation around Downey Playa, along lines sketched by Bartholomew (1982:60) for Clear Lake in Whitman County, Washington (Figure 20), is a predictable conse-

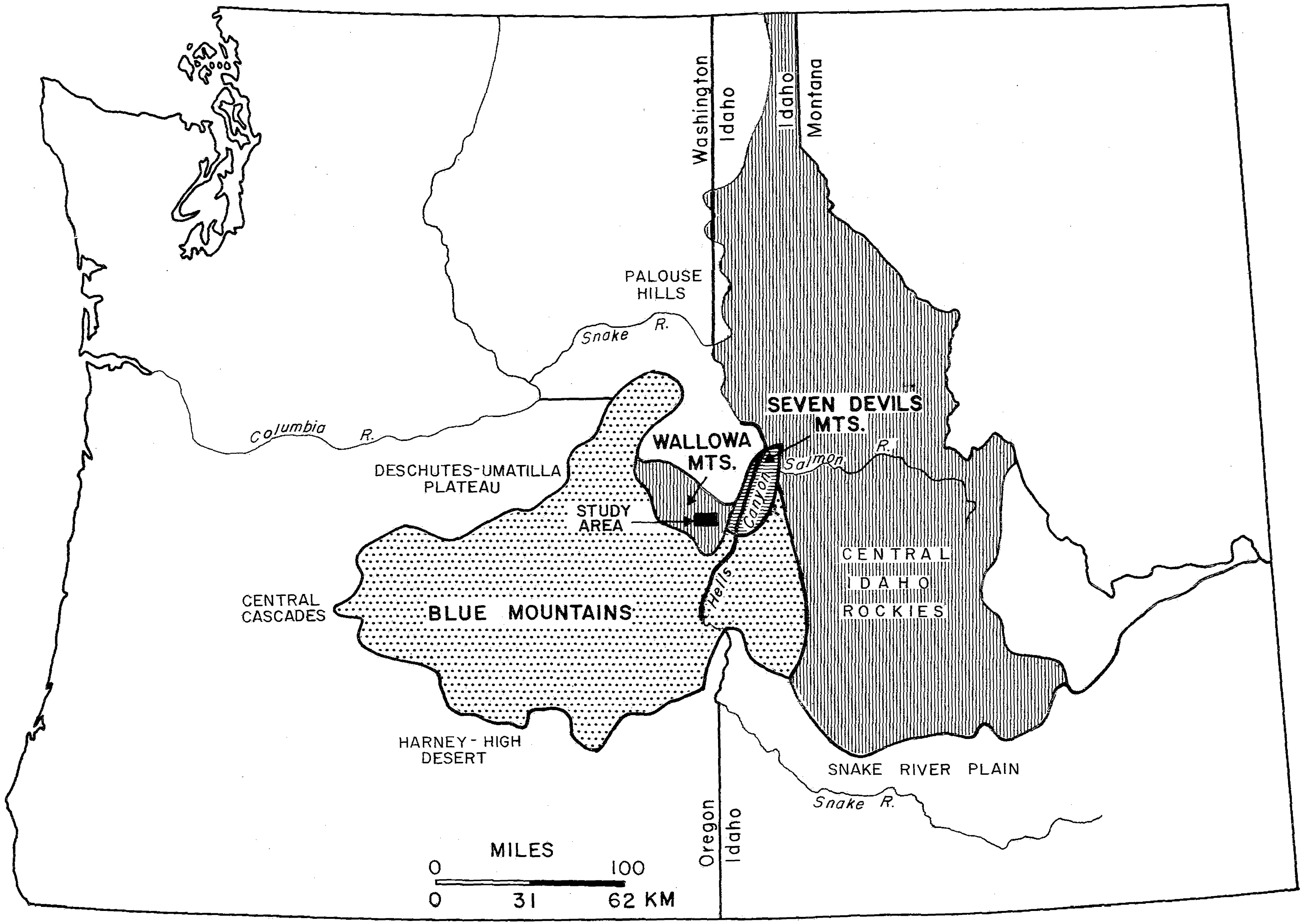


Figure 19: Location of project area.

quence after 1730. A further source of disturbance is suggested by the aboriginal practice of using shallow lakes and soft wet ground to break wild horses (Ewers 1955:61-62).

In addition to their localized impact on lake margin vegetation, horses may be implicated in more fundamental structural changes in the Imnaha basin environment. For example, an abrupt regional decline in native ungulates by the mid-nineteenth century has been documented (Dice 1919; Buechner 1953) but not explained (Gustafson 1983:39). Hunting pressure from horse mobile Indians and Euroamericans is a likely proximal cause, especially when the fully cursorial horse is compared to the semi- or noncursorial gaits of native ungulates. There are several historic accounts of horsemen simply running deer and elk into the ground.

The effects of the horse as an agent of ecosystemic change in its own right, decoupled from a hunting economy, should also be considered. Thus horses, as perissodactyls, can vary the rate of gut clearance while grazing, and are able to effectively use poorer forage that will not sustain native ungulates (Bell 1971; Geist 1974). Over time the wider feeding niche of feral horses compared to local ruminants might confer a significant competitive advantage to the colonizing species. Thus the collapse of regional game populations in the nineteenth century may have been preceded by nearly a hundred years of exclusionary competition caused by the wider grazing amplitude of feral horses.

Finally, the horse raises several well-known problems with the logic of "analogy by subtraction," or the argument that by looking at the ethnographic groups minus horses, guns, smallpox, revitalization symptoms, and other contact phenomena, we are seeing their late prehistoric antecedants. Some difficulties with this argument are shown by the example of the Nez Perce, where the introduction of horses resulted in: (1) increased intertribal or interband differentiation based on differential access to pasturage (Walker 1968:14); (2) development of intraband economic stratification based on horse wealth (Walker 1982:71); (3) geographic extensification of big game hunting to the contested buffalo plains of the upper Missouri basin (Anastasio 1975:132); (4) accelerated combat attrition among adult males so engaged, leading to (5) increasingly skewed sex ratios and the intensification of female subsistence activities (e.g., root gathering); resulting in (6) declining birth rates and increasing infant mortality rates due in part to the greater energy demands placed on pregnant women and lactating mothers (Drury 1958:137-138). In 1849, the missionary A. B. Smith predicted that the combined effects of disease, warfare, and "degradation of the females" would lead to the extinction of the Nez Perce population within a few generations (Drury 1958:136-138).

These effects suggest that the focus on root crops in several recent studies of Plateau cultural ecology (Hunn 1982; Hunn and French 1981; Ames and Marshall 1980) may be misplaced when applied to the prehistoric archaeological record. For example, while root crop intensification has been hypothesized as the trigger for the development of village sedentism 4,500 years ago (Ames and Marshall 1980:47), patterns of Nez Perce root harvesting observed since 1805 could also be interpreted to represent an intensification tactic brought about by readjustments in the sexual division of labor, and by a regional decline in game populations. Certainly, the suggestion that root crops provided more than 60 percent of caloric needs, or twice that of anadromous fish and six times that of game, and that mobility patterning on the Plateau was keyed to the seasonal and altitudinal distribution of carbohydrates (Hunn 1982:25, 36) departs from current understandings of forager subsistence behavior. Contrary to the widely cited but statistically biased findings of Lee (1968), hunter-gatherers at all latitudes acquire more calories through hunting and fishing than through plant gathering, and this bias is particularly pronounced among temperate latitude foragers in North America (Ember 1978: 440-443).

For these reasons, it is not assumed here that ethnographic patterns of plant use have much time depth, or that land use intensification implies increased use of plants through time. Instead, we expect that prehistoric foragers used the uplands mainly to "make meat," and that the placement of camps reflects primarily the different food and cover habits of elk, mule deer, bighorn sheep, and mountain goat. However, as discussed below, we do think that changes in the way ungulates were hunted can be used to test intensification models that postulate increasing stress through time between populations and resources.

Ethnographic Land Use Alternatives

The distribution and abundance of animals in mountain environments such as the Wallowas are limited less by low temparatures than by the combination of major seasonal or diurnal environmental oscillations, by a scarcity of nutrients, by low habitat diversity, and by ecosystem youth and insularity (Price 1981:304-313). Adaptations to these limiting factors include migration (elk, mule deer), hibernation (bear, marmot), burrowing (pika, wood rat), "withstanding" (bighorn sheep, mountain goat), and activity timing, especially the timing of feeding and breeding activities (Price 1981:325-330).

Although many studies of prehistoric adaptation to the area stress themes of migration and "burrowing" (e.g.,

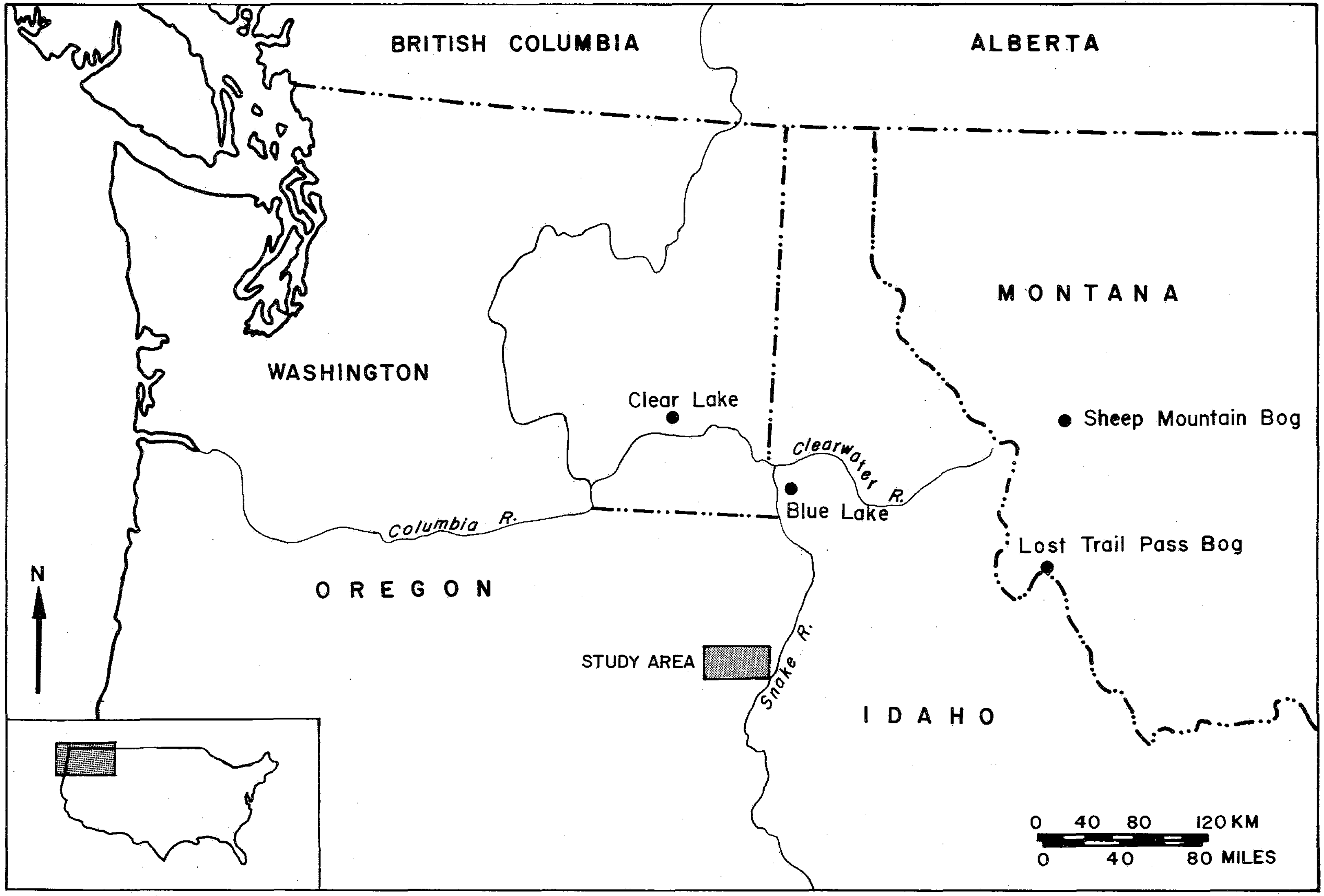


Figure 20: Location of paleoenvironmental sites discussed.

fall hunting and berry collecting in the uplands, followed by winter retreat to pithouse villages below 1,219 m), it is more realistic to view hunter-gatherers as adaptable "activity timers" in the highland ecosystem, capable of exploiting it at any season of the year and leaving a material record of their land use pattern. The ethnography and ethnohistory of the Northern Rocky Mountains suggests at least three such patterns: seasonal scheduling, permanent residence or "withstanding," and "fallbacking," or temporary (one- or two-generation) population shifts into the mountains in response to a lowland resource failure.

The "fallbacking" pattern is illustrated by Campbell's (1974, 1978) accounts of Nunamiut overkill of Dall sheep populations in the Brooks Range, in the Boreal Rockies of Alaska. Triggering this land use pattern is the periodic failure of a key migratory species to appear at expected intercept points. On the tundra, this was the caribou. However, in the Pacific Northwest, it has been argued that anadromous fish runs are similarly susceptible to catastrophic and unpredictable interuption (Sanger 1967; Brauner 1976:310). By analogy with the Nunamiut, Plateau foragers would fall back on mountain game reserves during periodic collapses of the salmon fishery. The distinctive feature of the "fallbacking" pattern is the rapid overexploitation of a reserve species not normally depended upon. In the Brooks Range, this was the Dall or thinhorn sheep. In the Wallowas, two candidate species were available, the Rocky Mountain bighorn sheep *(Ovis canadensis)*, and the mountain goat *(Oreamnos americanus)*. In addition, a regional change in fire regime would not be predicted by this kind of highland exploitation because of its discontinuous rhythm over time.

The endemic or "withstanding" pattern is exemplified by the Tukudika or Sheepeater Shoshone, who settled permanently in the uplands of the Salmon River range to the east, and in the zone above 2,500 m on the Yellowstone Plateau in the Middle Rockies of western Wyoming. Although they exploited the entire spectrum of upland resources, the focal animal was the bighorn sheep, pursued with the help of both snowshoes and dogs (Hultkrantz 1961:27). Often dismissed as unrepresentative and marginalized refugees from intertribal conflicts on the plains, the Tukudika nevertheless demonstrate the viability of an alpine "withstanding" strategy for low density populations of bow- and snowshoe-equipped foragers.

Seasonal scheduling is illustrated by the native Nez Perce, who increased habitat diversity in the Blue Mountains by broadcast burning of vegetation, then focused their late summer and fall berrying and deer and elk hunting on the burns, before shifting downslope to winter in canyons. Marshall (1977) provides considerable detail on pedestrian Nez Perce exploitation of mountain habitat. Subsistence was focused on six ungulates and five species of berries. Elk, mule deer, and white-tailed deer were more important than bighorn sheep, mountain goat, and moose. Game accounted for 10-25 percent of Nez Perce diet on an annual basis, but most of this intake occurred during the hunting season, between July and September. Each species was hunted either before or early in its rutting season. Winter range for elk and mule deer, which extended up to the western hemlock zone, was deliberately fired to improve browse conditions. Burning also improved the productivity of all five of the mountain berry resources. These included thimbleberry, serviceberry, mountain elderberry, huckleberry, and fireberry, all harvested in late summer and early fall.

Hunting tactics included the individual ambush at intercept points such as salt licks or wallows, and the group drive. Hunting grounds were rehunted by the same groups year after year, and campsites were carefully maintained for future use. Mountain camps were located 10-16 km apart in the heads of tributary basins, and occupied for 2-8 days each, depending on hunting success. Movement between camps was along the ridge systems linking valley heads. Group size at these camps ranged from 20-30 people, or five to six nuclear families with one hunter in each.

These figures give us a start in predicting archaeological site distributions on the upper Imnaha during the late Snake River Period. Modeling an average band size of 500 (Marshall 1977:148) for the Imnaha division of the Nez Perce, an average group size of 25 for mountain hunting parties, an average hunting season length of 90 days, and a maximum hunting camp occupation of eight days, gives us a total of 225 separate camping episodes each year.

If this kind of land use has a time depth of several generations or centuries, a pattern should be identifiable that consists of less than 225 hunting camps spaced at 10-16 km intervals along the upper reaches of tributaries headed by the same ridge system. Site assemblages should be dominated by chipped stone debris associated with hunting and butchering and occasional hopper mortars and hammers used for berry processing. Pithouses and tipi rings are not anticipated, but site structure may be defined by the distribution of fire cracked rock, and by boulder arrangements indicative of post supports or "site furniture." Finally, the start of intensified seasonal scheduling in the uplands above 4,500 feet may be registered in lake deposits by a change in fire regime, for example, by a shift from irregular severe crown fires to periodic light surface fires.

Excavations at Clear Lake Ridge

Previous Research

In 1983, the Forest Archaeologist and a small crew of technicians excavated three 1 x 1 m units at 35WA615 and one 1 x 1 m unit at 35WA616. 35WA615 is located at 4,820 feet on a small north-facing bench in a ponderosa park. It has a surface scatter of not less than 750 m^2, and culture bearing deposits extend to at least 110 cm. 35WA616 is located on a narrow alluvial terrace 700 m downslope at an elevation of 4,600 feet. It has a surface scatter of not less than 50 m^2, and cultural deposits extend to at least 80 cm.

Both 35WA615 and 35WA616 are well placed for observing and intercepting migrating ungulates. The transhumant fall and spring migrations of mule deer and elk along the wooded or shrubby floors and lower slopes of Bear and Devil's gulches, and Little and Big Sheep Canyons, can be monitored from the summit and upper slopes of Clear Lake Ridge (Figure 21). In late fall and early winter, bighorn sheep and mountain goats move downslope along open ridges rather than wooded defiles, where they graze on windswept flats close to steep escape slopes. The Clear Lake Ridge area was favored winter habitat for bighorns and goats until the 1890's (Bartlett n.d.), and 35WA615 and 35WA616 are well suited for intercept hunting of these animals in fall and early winter. In addition, the skyline between upper Downey Gulch and Downey Playa would let hunters camped at either site stalk game along the lake edge without alerting the animals.

The lithic assemblages at both sites consist mainly of flake tools and bifaces and associated manufacturing and maintenance debris. Raw materials include a dark gray to black basalt, red ignimbrite, black obsidian, and various cryptocrystalline silicates (chert, jasper, etc.). The basalt and ignimbrite outcrop locally on Clear Lake Ridge. The nearest source of obsidian is the Dooley Mountain area 115 km to the southwest. The silicates probably derive from alluvial gravels in the lower Imnaha valley, 25 km to the northeast. More than a third (35%) of the chipped stone assemblage at 35WA615 consists of exotic obsidian and silicates, while only three percent of the 35WA616 lithics are made from these materials (Table 12). Because the projectile points at 35WA615 are typologically earlier than those at 35WA616, these differences in raw material exploitation may indicate intensified land use resulting in smaller exploitation territories over time.

Recovered organic materials include carbonized wood and mammal bone. Large and datable pieces of wood charcoal are especially abundant in Levels 3, 7, 9 and 10 of Test Pit 3 at 35WA615, and in Level 6 at 35WA616. No flotation samples were taken from the test units, but the good preservation of bone and wood charcoal suggests that carbonized seeds may also be preserved. Identified fauna include bighorn sheep *(Ovis canadensis)* and one or more fossorial rodents. Examination of the large mammal specimens shows differences in cooking or bone disposal between the two sites. The sample from 35WA615 consists of very small fragments of calcined bluish white to neutral white specimens, while the bone from 35WA616 consists of much larger naturally yellow or surficially blackened specimens.

Although a weak tendency for bimodality is present in the vertical distributions of chipped stone from both 35WA615 and 35WA616 (Table 12) with the primary mode at 20-30 cm, and the secondary mode at 50-60 cm, it probably reflects pocket gopher faunalturbation rather than discrete occupational episodes (Erlandson 1984). Rodent remains were recovered from the 35WA616 test pit, and the loose loamy sediments at both sites are easily burrowed by small animals. This hypothesis is supported by the rank ordering of chipped stone raw materials in each test pit. If two occupational levels were discernible, we might expect differences in raw material exploitation to occur that were comparable to those that occur between the two sites. Such a condition would be sufficient, though not necessary, to reveal two occupational levels, but it does not occur. Instead, at both sites and in all units, the rank ordering of raw materials remains constant except in levels with small samples, where random "lithic drift" effects can be expected.

The best evidence for cultural and chronological differentiation between the sites is in the projectile point samples. At 35WA615 they are all within the size range of dart projectiles, and predate the very small arrow points recovered from Level 3 at 35WA616. In terms of regional culture history the sites are typologically contemporaneous with the later (Big Bar I and II) phases at Hells Canyon Creek rockshelter, 25 km to the southeast (Pavesic 1971). 35WA615 can be provisionally assigned to between about 500 BC and AD 500, and 35WA616 to between about AD 1000 and 1700.

Theoretical Approach

As a simple initial working hypothesis, we propose that there was no major change in adaptive patterning during the Snake River Period until the introduction of the horse 250 years ago, and that essentially the same subsistence pattern is represented at both 35WA615 and 35WA616. Evidence that would disconfirm this hypothesis includes: (1) recovery of carbonized grass seeds and seed processing tools in later deposits but not in earlier ones; (2) a shift

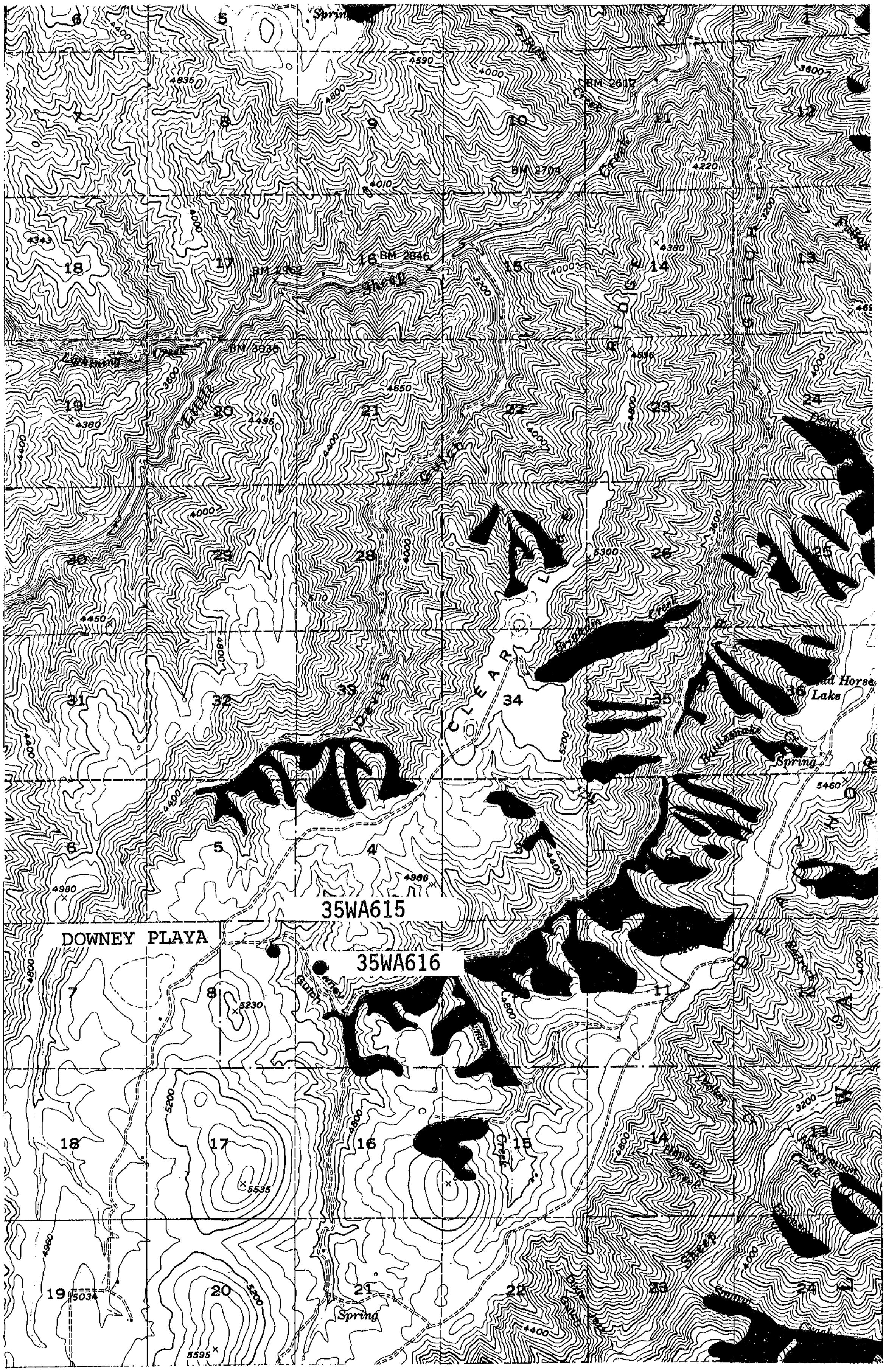


Figure 21: Location of Downey Playa and sites 35WA615 and 35WA616 on Clear Lake Ridge in the lower Imnaha Basin.

from predominantly bighorn sheep and mountain goat bones in earlier deposits to deer and elk bones in later deposits; (3) regular changes in toolstone catchments as reflected in manufacturing debitage and finished commodity raw materials; and (4) evidence for a later prehistoric anthropogenic fire regime in pollen and charcoal stratigraphy in lake sediments.

Because seed collecting is considered to be more labor intensive than root harvesting in terms of nutritional return, we expect grass use to correlate positively with population growth (Bettinger and Baumhoff 1982). And because bighorn sheep and mountain goats have sustained annual yields of between 10 and 11 percent and 5 and 10 percent respectively (Geist 1967; Chadwick 1983), compared with up to 30 percent for cervids (Mohler and Toweill 1982), we expect a growing population of hunters to focus increasingly on deer and elk over time. Debitage catchments should contract over time if a population is experiencing demographic "packing" at the regional level, leading to greater functional reliance on local toolstones (Reid and Artz 1984). At the same time, the raw material catchment of gift/commodity artifacts (highly formalized bifaces, copper ornaments, etc.) should expand as trade relations are extended to distant kinsmen as a form of social insurance against local resource shortfalls (Weissner 1982). Finally, paleoenvironmental evidence for increased frequencies of light surface fires provides a clue to intensification tactics such as deliberate suspension of succession and manipulation of ungulate pasturage (Shinn 1980; Clark 1983).

Methods of Proposed Research

Dimensions of variability that we intend to explore during the lithic analysis include: (1) tool size; (2) edge shapes and edge angles; (3) bifacing patterns; (4) hafting patterns; (5) lengths of debitage trajectories; and (6) raw material sources. Fluctuations in economic territories over time may be indicated by expansion or contraction of lithic raw material catchments. Economizing efforts reflecting changes in land use and mobility patterning may covary with changes in tool size, changes in the production of materially thrifty bifacial tools and core-tools, changes in wear-and-repair patterns, changes in debitage trajectories reflecting biface maintenance rather than biface production, and changes in tool hafting patterns. Exploration of these dimensions is encouraged by several recent studies linking variability in lithic artifacts to changes in how land and time are used to acquire food (e.g., Ebert 1979 on tool size and hunter mobility; Tainter 1979 on edge shapes and angles and activity analysis; Keeley 1982 on hafting and retooling; Binford 1979 on anticipatory vs. expedient tool design; Raab et al. 1979 on "long" and "short" biface reduction sequences; and Torrence 1983 on time budgets and hunter-gatherer technology).

Analysis of faunal remains will include sorting, identification, sexing, aging, and measurement of specimens. Indexes of species abundance for mule deer, elk, bighorn sheep, mountain goat, marmot, and rabbit will be constructed, based on the number of identified specimens and the minimum number of individuals. In general, the methodological procedures for interassemblage comparison outlined by Klein and Cruz-Uribe (1984) will be followed. However, where fragmentation, calcination or both preclude taxonomic analysis, microscopic study of bone color, crystal structure, shrinkage and cracking patterns (Shipman et al. 1984) may inform on regularities in cooking and bone disposal activities.

Recovery of carbonized seeds and other plant parts will clarify the potential importance of playa-edge vegetation to subsistence. Constant volume samples from each unit level and all feature matrix will be processed by laboratory flotation rather than water screening in the field. Analysis of archaeological sediments will include radiocarbon and tephra dating of stratigraphic units, determination of sediment sources and depositional processes, and the evaluation of anthropogenic contributions to deposit formation at both sites.

Intensive Survey of the Imnaha Divide

Methods

The 1986 fieldwork will include intensive survey of at least 30 sample units in the upper Imnaha basin between Indian Crossing and Marble Mountain, and coring of Duck Lake on the ridge overlooking Indian Crossing (Figure 22). Duck Lake will be cored from a raft mounted drive tower stabilized near the steep rocky southern rim, where the sedge filter is locally absent. The catchment of this site should inform on climatic change as reflected by changing frequencies of lodgepole and ponderosa pine and Douglas fir pollen and macrofossils, and on fire history in the upper Imnaha as revealed by macroscopic bedded charcoal.

The archaeological survey universe includes 60 square miles (155 square km). We have a target sample fraction of 5 percent (775 ha), which we intend to examine using a four person crew for a 25 day period. CNA staff archaeologists have found that intensive surface survey in comparable interior Pacific Northwest settings requires about 10 acres (4 ha)/person-day for forested surfaces, and 40 acres (16 ha)/person-day for open surfaces. Our reduced

Table 12: Variability in Raw Material Frequencies in Chipped Stone Assemblages at 35WA615 and 35WA616, Clear Lake Ridge

35WA615: Downy Gulch Site

	Chipped Stone					FCR	Bone
	Basalt	Ignimbrite	Obsidian	CCS	Total		
Surface	18	15	10	–	43		
Surface	2	41	2	–	45		1
Test Pit 1							
0-10	11	3	1	–	15		
10-20	17	4	6	1	28		
20-30	20	5	6	1	32		
30-40	10	9	2	–	21		1
40-50	11	2	3	1	17		
50-60	2	2	1	–	5	–	–
	71	25	19	3	118	0	1
Test Pit 2							
0-10	7	6	–	–	13		
10-20	26	22	–	4	54		
20-30	25	14	1	2	42		
30-40	23	13	1	2	39		1
40-50	4	6	–	–	10		
50-60	9	8	1	–	18	–	–
	94	69	3	10	176	0	1
Test Pit 3							
0-10	70	23	35	5	133		1
10-20	57	36	42	5	140		4
20-30	132	47	67	18	264		12
30-40	65	13	33	4	115		16
40-50	68	24	24	8	124	3	16
50-60	68	22	41	8	139	–	–
60-70	45	10	40	5	100	5	28
70-80	39	17	31	6	93	–	8
80-90	24	20	16	6	66	1	6
90-100	22	27	26	4	79	1	18
100-110	22	15	25	9	71	7	3
	612	254	380	78	1324	7	112

35WA616: Magpie Site

	Chipped Stone					Groundstone	FCR	Bone
	Basalt	Ignimbrite	Obsidian	CCS	Total			
Surface	35	5	2	–	42		1	
Shovel Test	4	1	–	1	6		5	
Test Pit 1								
0-10	37	7	–	1	45		4	4
10-20	52	16	1	3	72		1	9
20-30	36	27	–	2	65		3	16
30-40	15	13	–	1	29		3	5
40-50	35	14	–	–	49		10	16
50-60	66	20	–	3	89	1	14	21
60-70	40	17	–	–	57		5	20
70-80	20	12	–	2	34		14	9
80-90	2	2	–	1	5	–	–	–
	303	128	1	13	445	1	54	100

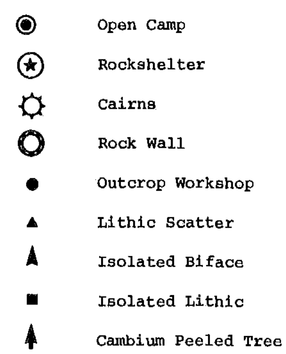
rate estimate of 7.75 acres/person-day reflects the logistical constraints on backcountry fieldwork in a roadless area.

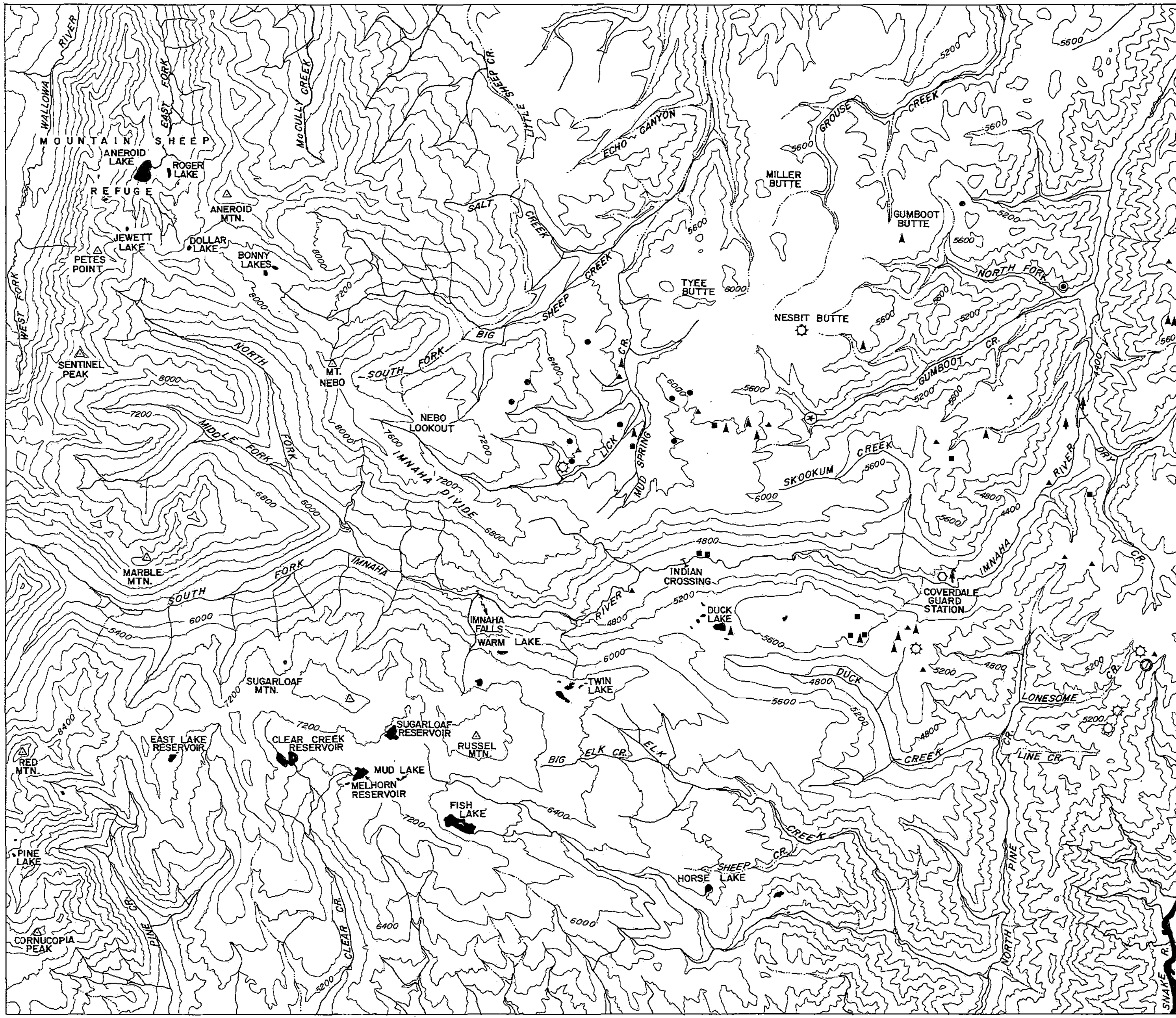
The area will be stratified to include subalpine flats (grade less than 15%), subalpine slopes (grade more than 15%), alpine flats (above timberline but with soil development), and alpine ridges (above both timberline and the zone of soil development). Subalpine flats are further classified as either open (meadow) or closed (forest). Sample units will be naturally bounded terrain facets rather than transects or quadrats. "Facet" refers to natural units of uniform terrain such as topographic benches, terraces, ridge spurs, or lake perimeters that can be map-recognized at scales of 1:10,000-1:80,000 (Mitchell 1974:48). These will be plotted on color aerial photos (1:15,840) and USGS topographic quads (1:62,500) that have been enlarged to 4 inches=1 mile tricompartment photomaps.

Quick and reliable recognition of culturally modified toolstones and fire cracked rock during fieldwork is important to the success of the project. In order to increase agreement and common recognition criteria among the crew, the first week of the project will be spent examining previously located lithic scatters in the drainages of Big Sheep and Gumboot creeks (Figure 22). These sites will not be collected, but debris scatters will be flagged, mapped, and recorded in terms of artifact morphology, function, and material. This procedure will also generate a key for the identification of fire cracked rock, a debris category absent in the extant inventory and timber sale survey records.

Sample land facets will be searched one at a time during the remaining 25 days by a four-person crew spaced at reasonable intervals and following a zig-zag course across the unit. Isolated artifacts will be collected during these sweeps, and their positions flagged. Artifact clusters and feature boundaries will be flagged, then mapped and collected after the landform is searched. Different flagging colors will distinguish chipped stone, ground stone, fire cracked rock, bone and shell, and historic debris. Survey units will be subdivided as appropriate for sketch mapping and plotting of artifacts and features. A "total" collection strategy will be exployed, except where the size of a site or density of debris dictates subsampling. We think that intensive collection efforts are justified by the need for large enough sample sizes to detect interassemblage variability, and because of the difficulty of relocating small and diffuse lithic scatters under constantly and subtly fluctuating visibility conditions. Where surface indications warrant, shovel testing will be employed to determine depth of deposits. However, shovel testing will not be used as a site locational technique because of the time it requires, and because of the relatively good surface visibility conditions in the study area. Personal inspection of a transect of all sampling strata between Indian Crossing and the Boner Flats spur of Marble Mountain in June, 1984, showed that ground surface visibility ranged between 20 percent on forested flats and slopes, to 80-100 percent on alpine flats and ridges.

Figure 22: The upper Imnaha Basin, showing the distribution of prehistoric sites located during Forest Service inventory and timber sales. The area of the proposed intensive survey is between Indian Crossing and Marble Mountain.





WALLOWA RIVER
EAST FORK
McCULLY CREEK
LITTLE SHEEP CR.
MOUNTAIN SHEEP REFUGE
ANEROID LAKE
ROGER LAKE
ANEROID MTN.
JEWETT LAKE
DOLLAR LAKE
PETES POINT
BONNY LAKES
WEST FORK
SENTINEL PEAK
NORTH FORK
MIDDLE FORK
MT. NEBO
SOUTH FORK
NEBO LOOKOUT
IMNAHA DIVIDE
MARBLE MTN.
SOUTH FORK IMNAHA
SALT CREEK
BIG SHEEP CREEK
ECHO CANYON
MILLER BUTTE
GROUSE CREEK
GUMBOOT BUTTE
TYEE BUTTE
NESBIT BUTTE
NORTH FORK
GUMBOOT CR.
LICK CR.
MUD SPRING
SKOOKUM CREEK
IMNAHA RIVER
DRY CR.
INDIAN CROSSING
COVERDALE GUARD STATION
RIVER
DUCK LAKE
DUCK CREEK
IMNAHA FALLS
WARM LAKE
TWIN LAKE
SUGARLOAF MTN.
SUGARLOAF RESERVOIR
RUSSEL MTN.
EAST LAKE RESERVOIR
CLEAR CREEK RESERVOIR
RED MTN.
MUD LAKE
MELHORN RESERVOIR
BIG ELK CR.
ELK CREEK
LONESOME CR.
LINE CR.
FISH LAKE
SHEEP CR.
HORSE LAKE
PINE LAKE
PINE CR.
CLEAR CR.
NORTH PINE CR.
CORNUCOPIA PEAK
SNAKE R.

Questions

We plan to integrate the data from this survey with the excavation and lake core data from Clear Lake Ridge in the final report. The results should help refine existing hypotheses and generate new ones concerning land use in the Northern Rockies during the last 2,000 years. Among the problems that we plan to explore are:

- How does assemblage composition and site structure vary along the elevation gradient between Clear Lake Ridge and Imnaha Divide? For example, do sites at higher elevations display the patterned and redundant structure implied by the Nez Perce analogy of stewarded mountain camps?

- Can functional correlations be established between habitat type and tool distributions? For example, do different point types covary with timber/cervid or meadow/bovid habitat types? Do points cluster along seasonal migration corridors, for example along timbered defiles for cervids, and along grassy ridges for bovids? What kinds of assemblages are found at "pace-changing" points along the Imnaha River such as Imnaha Falls or the Blue Hole, where anadromous fish could be intercepted?

- How does variability in lithic raw materials pattern within assemblages? For example, are projectile points usually made of exotic stone, and utility tools of local stone? Does variability in toolstone use change in a regular way over time? How does the distribution of obsidian from the south, cherts and jaspers from the canyons to the north and east, and basalts and ignimbrites from project area ridges inform on either one-group mobility patterning, or two-group interaction such as trade, migration, and colonization?

- Do seasonal hunting camps cluster in first order stream headwaters above 4,500 feet, as suggested by Marshall (1977), or along second order or higher confluences below 4,500 feet, as suggested by Schwede (1970)? Mountain ungulates tend to escape upslope when alarmed, and the siting of camps in the upper reaches of tributaries but below the skyline of feeder ridges seems advantageous in terms of both overview and exploitation of stereotypic behavior in prey animals. If we assume that the energy costs of ungulate hunting relate primarily to finding and killing animals, while the costs of plant gathering relate mainly to transporting bulk foods back to a processing/consumption point, we might anticipate that irregular site catchments (using isochrons based on day-walk radii) will be typical of hunting sites. However, if highland camps cluster lower in the drainage basin, and are placed so as to maximize access to root crops, as argued by Schwede (1970:133), their catchments should tend to even out. These arguments can be evaluated by comparative study of artifact assemblages, fire cracked rock distributions, and measurement of day-walk isochrons, with time-distance calculated at two hours for 6.2 miles (10 km) on the flat and 0.5 hour for every 984 foot (300 m) variation in altitude (Bailey and Davidson 1983:94).

- Finally, how does the fire history of the Imnaha basin compare with recent records from Lost Trail Pass (Mehringer et al. 1977) and Sheep Mountain (Hemphill 1983) bogs and Blue Lake (Smith 1983) in the Northern Rockies (Figure 20)? Increased frequencies of light surface fires are documented at Lost Trail Pass by 2,000 BP, at Sheep Mountain by 2,000 BP and especially after 1,100 BP, and at Blue Lake after 700 BP. These changes in fire regime are thought to reflect intensified aboriginal land use. Can a similar pattern be identified in the Wallowa Mountains?

WORKING GROUP

DOCUMENTS

Following presentation of the formal papers and subsequent group discussion of issues and concerns raised in them, the conference participants were separated into three "working groups" whose objective was to draft a set of proposals and guidelines for the Forest Service to use in improving their future inventory planning efforts. All groups worked on the entire objective, but each used a different format, so the resultant "working papers" show significant differences. The papers are presented here as a summary of the ideas and suggestions produced by the three groups.

WORKING PAPER

Group 1

Predictive/Explanatory Modeling

Predictive models should be developed when an adequate ("tested" or "replicated") data base is available *or* when anthropological/archaeological models are available which are specific enough to guide the planning of surveys. They should be developed in a situation that will engender resource responsibility. Predictive models would be developed by the Forest Archaeologist(s) involved, in concert with professionals working in and/or knowledgeable about the area.

Predictive models should produce relevant anthropological and distributional information and be used to guide cultural resource inventory on National Forests (i.e., rather than being used to "clear" large areas without field survey and verification).

Predictive models should be developed at a regional level, based on broad environmental-geographic boundaries, such as drainage basins. Such models should contribute to statewide plans and be subject to professional peer review beyond normal SHPO involvement. The model(s) should be tied to, or supercede, a Forest inventory plan. They should be a Forest management tool rather than a "compliance" tool, and should highlight probability areas where data collection is needed.

Predictive models ideally need explicit "causal" mechanisms rather than correlative ones. They should distinguish between behavioral and natural factors, and should attempt to recreate and explain original site distribution patterns as well as take into account site discoverability variables, and refine site "discovery" strategies. In short, they should be scientifically based on the widest variety of evidence relating to the distribution of discoverable sites across the landscape. They also need to be testable and flexible.

Sampling Design

Probability for site discovery in any area is dependent on factors of present and past environment, human adaptation to the environment, and behavioral factors. However, the present survey standards for coverage and probability zones are mainly based on known site locations.

One concern about the present methodology is the potential that surveys conducted on *a priori* probabilities may be self-fulfilling prophecies, subject to legal challenges of their compliance with 36 CFR 800.

Data used to assess site probability distribution will include:

1. Periodic, at least biennial, analysis of extant site locational data to determine the accuracy of areal definitions of probability. This should include a written analysis of factors causing anomalies in site distribution, when they occur.
2. Ethnographic information.
3. Informant contacts, including interviews with collectors.
4. Interviews with professionals who are now or who have in the past inventoried in the area.
5. Computerized spatial data bases such as R2, TRI, and GIS.
6. A written analysis of site associations with environmental factors.
7. A written test of site locational data against factors of past environments and past behavioral information. The test will list anomalies and attempt to explain them.
8. Consideration of site discoverability factors.

Following the compilation of this information and analysis, the relevant factors and how they are used in determining probability zones will be documented with examples and layout methodology.

The goals of sampling can best be established in the context of the research design. Although sampling has frequently been viewed as an alternative to complete inventory, it must be emphasized that *all* archaeology is sampling. Sampling, as we are concerned with it here, has to do with the way in which project areas are surveyed—the intensity or fraction and the method of ground coverage (e.g. transect, quadrat, point, etc.). The primary goal of sampling in archaeological survey is to obtain reliable information on the distribution, nature, and possibly the significance of archaeological remains across a study area.

Considerable concern has been expressed about the use of surveys over *portions* of a project area to clear the *entire* project area. Once it is recognized that there is no alternative to sampling, then questions regarding its use in compliance activities can be reduced to "what levels of intensity or what methods and techniques will adequately characterize the archaeological record of a project area?"

Sampling percentages for empirically determining site probabilities should depend on the following considerations:

1. the desire to identify as many sites as possible with available resources,
2. the need to sample areas large enough to reasonably characterize the target population,
3. the absolute size of the strata themselves (the smaller the area, the larger the needed sampling percentage), and
4. the anticipated density of sites within the sampled area (the less dense, the larger the sample needed to characterize the area).

Once the study area has been defined, the total percentage of the area to be sampled should be based on the allocation of resources for the purpose (whether it be 30%, 50%, etc.). The sampling percentage for the lowest probability area should be the minimum required to measure the site density there within *reasonable* confidence limits. The remainder of the area surveyed should be divided between the other probability strata, with the greater amount devoted to the higher probability stratum. If possible, the highest probability stratum should receive complete coverage.

These sampling percentages are considered independently of area within the study zone that has undoubted zero site discoverability. Such areas may not be appropriate for survey prior to ground disturbance, and do not fall within the sampling strata. Zero site discoverability is defined as resulting from natural rather than behavioral factors.

Impact areas, when designed and laid out, may be surveyed and checked by cultural resource technicians when appropriate during the course of their other field duties. Sites that are discovered will be treated in the same manner as those found during formal compliance-level survey.

In-field Survey

Some archaeological sites are buried and cannot be seen on the surface. Therefore, how do we sample (survey) below the surface? A list of procedures to be followed may include:

A. Survey all natural and man-made subsurface exposures (referred to as "windows"):
   1. river banks
   2. tree tip-ups
   3. road cuts
   4. rodent burrows

B. After this, look at the categories of landforms for which there are and are not such "windows".

C. Identify categories of landforms in which "windows" would not be relevant:
   1. bedrock benches
   2. glacial till deposits
   3. avalanche slopes

D. Using the above information and any other relevant data, identify which categories and locations of landforms have the highest potential for buried sites, and then design some kind of subsurface probe technique.

E. Recommendations:
   1. The decision to undertake subsurface testing and the choice of location(s) for such tests should occur within the context of a research design.

   2. Subsurface probing should be used on landforms which have highest potential to yield sites.

   3. The nature of the proposed project impact and its depth must be considered in evaluating the need for and in designing a subsurface probing exercise.

   4. Tie in with site location model should be used to *focus* testing at specific locations (this is a very good use for predictive models).

In-Field Survey Documentation

The basis for empirically testing (or "replicating") a predictive model or inventory plan rests on well-documented field searches. These data are also the basis for the development of inventory plans, predictive models and sound resource management.

Better, more accurate field data than those presently available are required. This information should include uniform landform taxonomies, visibility conditions, explicit conditions at time of survey, accurate field maps, transects, etc. in both survey report and site forms. Resurvey is needed to check work adequacy and to test areas of no visibility.

WORKING PAPER

Group 2

In-Field Survey

The goal of field survey is to find all sites. Positive aspects of current procedures include:

- sites are being located;
- a standardized format is used for the recording of data; and
- the accumulation of data towards the goal of complete inventory.

However, it seems probable that current procedures also:

- fail to find sites in certain environments;
- involve ambiguity in the definition and treatment of certain types of sites (especially isolated finds);
- may result in incomparable data due to differing tactics currently in use (transects versus quadrats, for example).

Recommendations

On a policy level, methods to find all sites need to be improved. On a strategy level, this will involve improving site discovery procedures, having a clearer definition of "sites," and perhaps formulating new survey (inventory) procedures. On a specific tactical level, site discovery procedures could be improved by:

- increased use of ASC (Archaeological Survey Calibration, traditionally called monitoring; see below) in areas where surface visibility is low;
- creation of a "paper trail" to assure that ASC does in fact take place;
- creation of documentation for ASC.

Clarifying site definition could be accomplished by

- clearly defining site versus isolated find;
- promoting marking of sites to make relocation easier;
- developing tickler files for contemporary sites (that is, under the 50-year threshold).

Improving survey inventory procedures may involve

- creating means to alter specific survey inventory plans to minimize biases. Involve randomizing factors.
- creating means to feed ASC results back into the inventory plan;
- tie reentry and ASC actions into the survey inventory plan.

Immediate actions that can be undertaken include:

- confirm status of "isolated finds" and insure their recording;
- encourage Forest Service archaeologists to meet with and discuss their procedures with other professionals to create state of the art approaches;
- encourage the professional community to use Forest Service survey data to test and/or model inventory methods as part of the professional community's research in archaeological methods; and
- develop monitoring report format.

Sampling Design

The goal is to develop a site survey sampling design that will result in the discovery of all "locatable" archaeological sites in a cost effective manner. Sampling designs must deal with the problem of assessing the likelihood of the following circumstances in any given application:

- sites were formed in this project area;
- sites were formed but have been destroyed and no longer exist in this project area;
- sites were formed and do exist in this project area today, but due to their formational histories, they cannot be located with standard site discovery procedures.

Clearly, the implications of each of these possibilities are quite different for ascertaining whether an archaeological survey is adequate or complete (that is, all sites in the area were found). The two stages of survey to be described below, in conjunction with the construction of correlative

or explanatory models for site location, should ultimately allow assessment of sample adequacy. As well, the recommended two-stage survey strategy will result in the discovery following Stage I survey of many "pristine" sites which can be avoided, or for which the impending impacts can be mitigated, and a number of sites during Stage II which have been exposed as a result of land modification activities and thus are less than "pristine." *All* of these sites, regardless of how intact they may be, provide important data for evaluation of either correlational (inductive) or explanatory (deductive) locational models. Ultimately, the sampling design proposed below should result in the discovery of all "locatable" archaeological sites in a cost-effective manner—meeting the explicit goal of the sampling design.

At present, the Forest Service is locating some sites by using a sampling strategy founded in/structured by intuitively-defined zones of site occurrence probability. Given the nature of these intuitively-defined zones, the possibility exists that some sites are not being located. Because all archaeological survey ultimately involves sampling, all survey must include methods for evaluating the degree of sample completeness and representativeness. Although the need for monitoring has been recognized, monitoring has not been done in a systematic way on all forests. Since a sample design serves as the interface between field survey and the predictive/explanatory model, there must be constant feedback between the elements and subsequent modification of each element.

Recommendations

A. Policy

The Forest Service should develop a sampling design that is based upon a predictive/explanatory model, and which will result in the unbiased discovery of all locatable sites. The sample design should include self-evaluation mechanisms, including quality controls and measures of confidence. Assessment of sample adequacy cannot be based on sample size or the discovery of sites by serendipity, but rather must be based on probability theory and use specific expectations derived from the locational models.

The strategy must take into account the fact that the Forest Service has neither the funding nor the personnel to survey all land units within the time frames dictated by Forest projects. Therefore, the strategy underlying the sampling design must somehow incorporate an empirical testing procedure for assessing sample adequacy. The most efficient way to accomplish the desired goal (to discover all locatable sites) is with a two-stage sampling design that involves probabilistic and purposeful facets in both phases.

B. First Stage

Present practice involves survey of a sample of intuitively defined and selected sample units within a project area. It is not known at the time of survey if those chosen units will ultimately be impacted, or if some other units not surveyed will be impacted. A major concern is that under this reconnaissance practice some sites might not be discovered. It is recommended that this first stage of survey be structured in the following ways so as to increase sample size and provide means of assessing sample reliability:

- Draw an initial randomly chosen set of sample units from the entire project area, perhaps stratified along the intuitive lines presently in use; this will allow assessment of sample adequacy and estimates of population parameters. The recommended minimal sample proportion is 25%.

- Survey all other, non-randomly drawn sample units that fall within the intuitively defined high and medium probability zones based on criteria in use today, comparing results to estimates in randomly drawn sample. As well, survey all areas where the potential for site discovery is high, such as natural exposures.

- Survey all other areas where the predictive/explanatory model suggests sites may be located. Note that the randomly drawn sample will serve to insure against a built-in tautology between the model and the survey results, avoiding the "self-fulfilling prophecy".

C. Second Stage

Present practice involves incomplete and non-systematic archaeological survey calibration (ASC) of impacted portions of project areas. Recommendations are to begin a systematic and complete ASC (re-survey) of *all* impacted portions of project areas, plus any other areas where the potential for site discovery is greater than it was during first stage survey. This stage will insure the discovery of any sites missed during the first stage, and can serve as a check of the adequacy of the first stage.

D. Feedback

The results of both stages of survey will provide feedback to the explanatory/predictive model and suggest how that model should be modified to account for *all* site locations. All results should indicate the adequacies and deficiencies of field survey strategies; e.g., was the time of year appropriate? was the interval between surveyors appropriate? was the correct kind of cultural material being looked for?

Predictive Locational Modeling

A locational model is one which predicts, minimally, the locations of various archaeological materials or sites on the landscape. A locational model *may* be explanatory in nature. An explanatory locational model links human behavior in its past social and environmental context, with an observable distribution of archaeological materials.

Current construction incorporates past survey experience in locating archaeological resources into the formation of disproportionate stratified survey samples for concentrating survey effort on high probability locations. To the extent that such models are accurate, they tend to maximize site discovery/dollar (other problems, such as vegetation, being equal) without totally abandoning survey in areas similar to those in which past surveys have located few or no materials. Such procedures also have the advantage that they do not require statistical expertise or access to computational facilities. Intuitive model building involves little or no expense for model construction.

However, there is currently a lack of formal statistical testing or validation of Forest Service locational models, so their accuracy is either unknown, or only intuitively estimated. The largely inductive basis for most such models results in estimates for archaeological resource occurrence that are subject to the same discovery and analytic biases as are the sample on which the estimates are based. Even an inductive model which is successful in one valley may not be in a neighboring valley; inductive models have low generalizability. Finally, even accurate inductive models may not explain archaeological resource distribution and may therefore provide no interpretive or evaluative framework for these resources.

Recommendations

As a policy goal, the Forest Service should develop accurate and reliable inductive locational models for archaeological resources for use in multiple-use planning and in designing survey strategy. At the same time, deductive (or explanatory) models should be developed, beginning with accurate paleoenvironmental reconstructions, taking into consideration alternative possible human decision mechanisms and goals, and competing plausible cultural historical reconstructions. Deductive models will provide a framework for evaluating and interpreting known resources, and for predicting probabilities of archaeological resource occurrence where survey data is presently absent or seriously biased.

Still on the policy level, the Forest Service should undertake intensive calibration studies (ASC) to determine the degree of reliability for the distributional data on which current and future locational models will be based. The spatial resolution of current inductive models should be improved; they should be refined to take into account differing site and adaptation types; and they should consider a broader range of environmental variables as potentially significant for determining location.

Strategies for achieving these goals include:

- acquisition or development of a high-resolution computerized spatial data base. Any system developed should include broad data acquisition, analysis, and display capabilities. It should incorporate all available environmental data, especially variables relating to topographic, hydrologic, and vegetational distributions. Data on site location, type, and content should be computerized in a format that is compatible for use in the larger spatial environmental data base, and mechanisms for guaranteeing the confidentiality of these sensitive data should be developed.

- given the important role of resource distributions in determining the locations of hunter-gatherer settlements and extractive activities, current ability to take into account changing resource distributions through time needs to be assessed and perhaps improved. Successful deductive modeling will require increased emphasis on paleoenvironmental reconstruction;

- the establishment of a student intern program with the mutual goals of providing training and experience (and perhaps a thesis topic) for the student; reinforcing Forest Service and academic institution ties; providing access to Forest Service data for researchers; providing access to university computational resources for the Forest Service; and frequently updating and refining inductive and deductive locational models for forests as student projects.

- by F/Y 1986, a pilot study should be undertaken that produces an initial computerized inductive locational model accompanied by one or more preliminary deductive models. The success of this effort should be evaluated during an on-site conference by a project advisory team composed of Forest Service and other professional archaeologists.

WORKING PAPER

Group 3

In-Field Survey

The current site recording procedures of the Forest Service appear to be adequate, although their adequacy should be subject to periodic review. Specialized forms (or sub-forms) may prove necessary for use in particular situations. For example, more attention should be given to field recording of environmental context (e.g., to facilitate "ground truthing" of existing environmental data, and to aid in identification of localities with potential relevance to paleoenvironmental reconstruction). It should be noted that the use of survey forms (in recording information on areas surveyed, as distinct from site-specific recording forms) is a commendable Forest Service practice that might well be emulated by other inventory programs.

Attention should be directed toward a potential problem in the determination of location in the field. To effectively take advantage of modern geographical information systems (GIS) technology, the average margin of error in determining field location should be reduced to no more than 50 meters (the usual GIS cell size at present). To accomplish this, methods and techniques (e.g., use of portable LORAN units) should be developed to measure the accuracy of traditional methods (compass, map, aerial photo, etc.) under differing environmental conditions. Depending on the results of such studies, it may prove necessary to adopt more accurate locational methods for use in the field.

On the question of artifact collection vs. in-field analysis, it appears impossible to establish a universal rule; this decision should be based on professional judgement, situationally applied in the light of policy as formulated at the national and regional levels.

Field recording procedures should be consciously adopted, frequently reviewed, adhered to with consistency, and modified in the light of professional judgement rather than simple expediency.

Site Discoverability/Testing

Discoverability has been defined as the degree to which human use of a location has left traces that can be found by surface inspection (Pettigrew 1984). That definition can be expanded to include traces that can no longer be located by surface inspection due to post-depositional events and processes. The problem applies to the full range of local environments rather than being restricted, as is often thought, to the overgrown and damp west-side Cascades. Vegetation cover on National Forest lands, in combination with duff, deadfall, and geomorphic processes, significantly inhibits the ability of surveyors to locate and recognize cultural material.

Variables affecting site discovery must be taken into account. These variables include fire history, soil type, timber stand age, erosion rates and land stability figures, rate of duff build-up, effects of early splash dams and log drives in scouring creeks, etc. Most of these data, depending upon locational and data quality factors, could significantly contribute to our understanding of which processes might have altered, obscured, and/or removed site evidence from the archaeological record.

In the Pacific Northwest, site discoverability problems related to the region's dense forest conditions represent a major area of difficulty for the cultural resource inventory process. Thus, there is a clear need for technical refinements in the site detection tactics available to field surveyors. We believe that such on-the-ground approaches as soil chemistry studies and vegetation studies, as well as some remote sensing applications, may prove to be valuable in this regard. Further, we believe that it is unreasonable to restrict the investigation of such technical advances to a secondary goal of field investigators *while they are engaged in the inventory process.* For this reason, we believe that a strong case can be made for wholly methodological studies in addition to the inventory process. We recognize and applaud methodological efforts already undertaken by the Forest Service, and we urge greater consideration of these kinds of studies in the future.

In view of the environmental constraints on discoverability, we believe that there should be more widespread consideration of the use of subsurface testing as an adjunct to the surface inspection routinely employed in site survey. While such testing is not necessarily appropriate in all cases, and a variety of test procedures are available (i.e., soil augers, test pits, etc.), it may be generally noted that as discoverability decreases, the need for some form of testing increases. The decision to undertake (or not to undertake) a subsurface testing program is a professional decision, and it should be explicitly documented and justified in the study report.

Survey Intensity

Intensity is a dimension of variability on archaeological survey that has different quantitative values. It is not a value term in itself, and we should avoid talking about "low intensity" survey as if this was a qualitative judgement against someone or some group. The relevant considerations in quantifying intensity are effort, knowledge, time, and space. Discussions of survey intensity should include (a) the time spent in the field, expressed in man-hours, person-days, etc.; (b) the intervals between surveyors, expressed in tens of meters; (c) existing knowledge about site size and visibility; and (d) evaluation of survey results in terms of (a), (b), and (c).

Survey intervals should relate to existing knowledge about site dimensions, such as modes in the short axis or minimal diameters of lithic scatters. For example, if a probability zone is going to be inventoried using transects, a high intensity survey should have intervals narrow enough to locate low diameter sites, and a low intensity survey should have intervals wide enough to locate high diameter sites. The point is to use stable frequencies in the known site data to calibrate spacing intervals for each project area, and to hold the intervals constant across probability zones that have different coverage to consider the obtrusiveness of sites encountered.

Scheduling

In the Pacific Northwest, a variety of seasonal conditions can significantly impact archaeological site survey activities. In particular, seasonal weather patterns may have important effects on surveys and surveyors. Most dramatically, snow cover can obscure ground surfaces sufficiently to either substantially complicate or effectively preclude survey activities. Similarly, the short daylight and heavy rainfall conditions of the fall and winter months can often have a significant negative impact on the surveyor's ability to locate cultural resources. Finally, such weather-independent conditions as deer or elk hunting seasons may also have an effect on the surveyor's ability or willingness to operate in the woods. In the recent past, the scheduling of at least some site survey projects have appeared to reflect internal administrative dynamics rather than field considerations, and this has resulted in surveys being conducted under less than optimal conditions. In the future, we believe that project scheduling should be structured so as to optimize field inspection conditions.

Sampling Design

The USFS should continue to survey project areas using the boundaries of these areas to define sample units. When efficient, sample unit boundaries should be extended to include adjacent lands prioritized according to the Forest Cultural Resource Sampling Strategy(s).

Survey project areas and adjacent lands should be code mapped by sampling strata prior to field entry, but coding should be verified in field. In addition to areal sampling in project areas such as timber cuts, survey of roads and trails should be recognized as transect samples and linearly measured by sampling strata.

When opportunity exists for survey in non-project areas, sample units should be defined by natural units and randomly chosen from strata using systematically assigned priorities based on a Forest Cultural Resource Sampling Strategy(s).

Priorities assigned for survey of lands adjacent to project areas and lands not in project areas, should be developed according to criteria for both (1) a statistically representative sample of site types (intact) and land types, and (2) predictions made by considering implications of explanatory models of cultural ecology and evolution.

Statistically representative samples should be judged by absolute size of samples of land units and absolute frequency of site types (intact). This approach should combine the practicality of disproportional sampling of strata with the need to identify (if possible) a minimum number of sites (intact and of certain types) in each sampling strata.

Procedures to assess the statistical adequacy of sample size exist in mathematical and archaeological literature and should be implemented to document both the precision and accuracy of sample estimates for site (presence/absence, site frequency, and/or as necessary site dimensions such as artifact frequencies or site size). Sampling estimates should recognize connections based on measures of survey intensity and site discoverability.

Unless suitable extensive surveys of subregions are performed for land exchange or other large-scale projects, recognition must be given to the problem that dispersed sample unit survey will probably not help identify or explain the relative spatial relationship between sites.

Statistical assessment should occur at each step of a multi-phase sampling project designed to test successive sample based resource estimates. Each sampling phase should include the task of re-surveying a fraction of project areas when impacts may have potential to expose cultural resources.

Graphic and statistical capabilities of GIS will benefit the design, implementation, and evaluation of regional sampling strategies. Foremost among these benefits will

be the definition and accurate measurement of useful land classifications and the past human resource potential of land classes.

Sampling strata should include (1) a detailed dimension such as landforms, and (2) a general dimension of resource potential such as sub-regions. This approach provides identifiable survey units that can be located in the field and assessed according to factors determining site formation, preservation and discoverability. Also, sample estimates from landform survey units (categorized as similar) can be compared across the general strata defined by characteristic resource availability.

A rigorous sampling strategy, systematically designed and evaluated, will enable forest-wide cultural resource planning compatible with multiple-use resource planning.

The development of appropriate survey strategies, be they based upon probabilistic sampling or complete inspection must include a process for the adjustment of invalid, unreliable, or inappropriate design. The process includes the feedback of an analysis of survey results into the survey design stage and/or the in-field stage for selecting or testing more useful methods of data observation and collection. It also includes the utilization of simulation studies to check the validity and reliability of survey designs. This feedback cycle may operate on the same schedule as selection of in-field techniques, survey design and execution and model building and testing, or it may feedback directly to method selection and survey design on a more frequent interval. In the Forest Service scheme, this process is clearly one of the goals of cultural resource monitoring and should be built into monitoring plans.

Survey Replication and Validation

Replication and validation are among the most important aspects of the inventory process as they offer measures of the effectiveness of our sampling designs and the value of the data generated by them. Their use represents a multi-phased approach to the inventory process and they provide an empirical basis for refinements in survey design. Both replication and validation require additional field inspections, but they occur at different points in the inventory process and they represent different measures of effectiveness. Replication activities should occur after the initial field inventory, but before adverse impacts actually occur. The extent to which survey results can be reproduced must be considered to be one of the most fundamental measures of their value. At the same time, however, it must be recognized that it is possible to replicate false or misleading results and therefore it is also important to establish some measure of the survey's ability to accurately reflect the real world. As discoverability problems in the forest are largely a function of visibility, and as most types of adverse impacts have the effect of enhancing visibility, an assessment of validity may be made by the re-examination of project units following impact.

Survey Adequacy/Redundancy

The question may be asked, "When has the point of survey redundancy been reached?" Some people in the archaeological profession might respond that the question should not even be asked, that "Our work is *never* done!" However, this question is perhaps not so important as the other questions to which it leads: What *is* intensive survey? How *often* do we revalidate survey work and survey design? What risks, if any, are the professionals (Forest Service and non-Forest Service alike) willing to take? For example, will we ever take the risk that *significant* cultural resources simply do not exist (or cannot be found) within a particularly inhospitable and inaccessible type of terrain? We have been asking some of these questions—and often answering them to our recurring dissatisfaction—all along.

In the larger world, the Federal land-managing agencies, the OMB, Congress and the increasingly restive middle-class of American taxpayers all will probably expect that the need for archaeological survey dollars will decrease in the long run, not only because of increased efficiency in survey coverage but because certain areas no longer need to be surveyed. Bearing in mind this expectation, an increased proportion of available CRM dollars would then be used for the longer range (but no longer so "nebulous") goals of on-site management and interpretation. We cannot realistically expect the overall CRM slice of the funding pie to increase that much (although we all would be greatly pleased if it did); it may even shrink. We need to work towards cultural resource goals that will allow us—"to provide for the greatest good, for the greatest number, in the long run."

On a more practical, immediate level, we need to recognize the difference between the concepts of "adequacy" and "redundancy". *Adequacy* of survey converage is what we want. *Redundancy,* is what we don't want. Therefore, we need to be able to determine *when* we are redundant. The entire archaeological survey approach is multi-phased, and this implies repeated inspection of the same piece of ground. The converse of this involves the question of "under what circumstances is repeated inspection no longer justified?" When is it redundant? Examples of two relevant circumstances are: (a) When environmental conditions have changed significantly ("discernability"), and (b) when survey detection tactics/techniques have changed ("technology"). Above and beyond these, re-examination has fundamental roles in terms of both replica-

tion and validation assessments. Therefore, where environmental and technical conditions remain relatively constant, *and* replication/validation concerns have been adequately addressed, further re-examination is redundant and unnecessary.

Predictive/Explanatory Models

Regional research designs developed by the Forest Service should include historical and processual explanatory models. Historical models include conventional age/area or trait diffusion studies; cultural chronologies (including periodization and phase/horizon/tradition systematics); the Direct Historical Approach, starting from either Native American or Euroamerican baselines and working backward; and linguistic prehistory models that attempt to link broad regional changes in technology, art, or human biology to changes in the geographic distribution of Native American languages.

Processual models usually focus on demography, climate change, or the "evolutionary ecology" of human adaption. These models are usually more formal and quantitative than historical models, and often involve remote sensing and computer simulation as well as "ground truthing" and archival research. Demographic models often focus on the relationship between population, technology, and resource base. Climatic change models include long term studies of how changes in moisture and temperature, and short-term "catastrophic" events such as volcanic eruptions, mud slides, "El Nino" type events, etc. influence adaptation and subsistence. Evolutionary ecology is a cover term for several formal theories of limited scope and applicability borrowed from the natural sciences (optimal foraging, linear programming, etc.).

Data Requirements and Quality

Explanatory models are an essential part of the cycle of scientific investigation in archaeology. This cycle ideally should consist of problem formulation, data acquisition, analysis, explanatory intrepretation in terms of hypothesized past behavior, the development of test-implications, the performance of an actual test with comparable data, the resolution and/or reformulation of the initial problem and the formulation of new problems for research. From this standpoint, purely "inductive" predictive modeling is incomplete; so is purely "deductive" predictive modeling. Perhaps this is one reason why *either* approach, taken alone, often proves unsatisfactory.

From all this it seems to follow that the data requirements for *model building* may be quite different from the data requirements for *model testing* (certainly, to avoid tautology, they *should* be different).

For example, model *building* may require not only a substantial data base of site locations and context, but also a body of *environmental data* to support paleoenvironmental reconstruction. Likewise, model building may require a regional framework of chronology/culture history, the use of ethnographic analogy (direct-historical, and/or general causal-functional), etc.

Model *testing* will require site-specific, predictive test-implications: e.g., site structure and context, seasonality, spatial location, and dating. The data requirements for testing such implications will often be *quantitative,* rather than simply qualitative. Survey strategies should be designed which are appropriate to the model being considered.

This process of model building, testing, refinement and use should probably be called a "Cultural Resource Management Plan" or "Implementation Plan" in the language of current Land Management Planning procedure. Cultural resource survey includes the data collection/survey strategy part of the cycle, monitoring covers the testing of models and techniques, while evaluation, resource allocation, and management decisions result from the application of the model.

A research/management cycle must be complete and progress through it timely enough that corrections can be made before unacceptable errors in resource management information occurs. In order to assure that this process occurs, targets or goals need to be institutionalized into the performance evaluation system and management priorities.

Problems and Opportunities of the New Computer Technologies

GIS (Geographic Information Systems) is potentially an extremely powerful and useful tool for archaeological inventory, predictive modeling and other Cultural Resources Management tasks on the National Forests. The Forest Service is now at a relatively early stage of its involvement with GIS. Although GIS system design and implementation on the National Forests may not arrive as soon as currently scheduled, we would do well to anticipate its arrival through advance planning.

These are some of the major GIS action items for CRM:

1. Increase CRM's involvement in Forest Service GIS effort.

2. Identify key GIS "information-gathering" people at Regional Office and Supervisor's Office levels and assign them some tangible responsibilities/ time-lines.

3. "Key people" should attend on-going GIS meetings (and share information).

4. All CRM people should cultivate on-going contact with their units' GIS "coordinator"; ask to be kept up to date on administrative and technical changes.

5. Appoint a Region 6 CRM/GIS task group (i.e., after initial education campaign).

6. CRM should be represented on GIS steering team meetings; help formulate decision-making criteria for GIS design/implementation.

7. Concurrently, CRM needs to begin design of a flexible, GIS-compatible computerized site recording system (e.g., ASIS-type, Washington SHPO, etc.).

Together, all three tasks of education, communication and participation will allow the program to reach a basic competency level with the new technology. Only then can the Pacific Northwest Region's CRM program begin to grapple with its specific needs from GIS system applications. We need to remember that within the "big picture" of Forest Service GIS design and development, the part that CRM plays will probably be a relatively small one. But we must not forget that CRM's timely participation in the GIS design process could make a significant difference to the program down the line.

DISCUSSION

AND CONCLUSIONS

ROUND TABLE DISCUSSION AND CONCLUDING REMARKS

Following paper presentations a round table discussion was conducted to identify issues or problems to be addressed by three independent working groups.

The initial suggestion was offered that problems be discussed in three categories: (1) field techniques; (2) survey design and sampling methods; and (3) theoretical modeling. Although this outline was only loosely followed during subsequent discussion, a similar organization was adopted for working group documents.

At the outset of discussion, regional Forest Service personnel were able to further clarify and stress the goal they wished to reach with the help of the conference participants. At this time the principal objective was phrased as a question, for which an answer was sought: "Are we doing enough of the kind of inventory needed to find and evaluate archaeological sites?" This question was placed in the context of compliance with both Section 106 and Section 110 of the amended National Historic Preservation Act of 1980.

As discussed above by Whitlam, Section 106 pertains to project specific impacts to cultural resources, while Section 110 directs agencies to establish an inventory and evaluation program for *all* cultural resource properties that appear to qualify for the National Register. Within these guidelines, discussions indicated that it has become the Forest Service's (Region 6) goal to flexibly design a cultural resource inventory program that identifies *all* reasonably discoverable sites in project impact areas, while collecting site survey information from adjacent non-impact areas identified according to a Forest-specific sampling design.

Having listened to papers summarizing current Forest inventory practices and sampling designs, side by side with papers evaluating survey techniques, sampling methods and theoretical research proposals, the conference participants were in a unique position to assist Forest Service Cultural Resource programs by drafting recommendations for future inventory and predictive modeling applications.

These basic examples were raised regarding problems for which recommendations are needed.

1. How should an archaeological survey be designed?
2. Since all archaeological survey is a sampling process, how large a sample is needed to achieve "complete" survey?
3. What research questions should be addressed and how appropriate are these questions for developing sample designs?
4. Can issues of data quality and confidence be addressed through survey contract evaluation and/or post-impact project survey?
5. Under what conditions are predictive locational models appropriate to clear a project impact area as devoid of reasonably discoverable sites?
6. What similarities in research design and sample survey design might be shared between Forests in adjacent environmental regions?

Extended discussion produced the consensus that research questions related to explanatory models of culture history, cultural ecology, and cultural evolution were essential to future Forest Service inventory and site evaluation efforts. One recommendation in this area was to conduct a conference whose subject would be "Explanatory Model Building." There was also a strong concern voiced that site discoverability models (those dealing with site formation, landform, and vegetation biases) be given equal emphasis with subsistence and settlement models.

Final comments in the round table discussion were provided by Jim Keyser, who stressed again that the intent of the conference was to assess the status of the Forest Service regional inventory effort, compare that to the "state of the art" for archaeological survey in the Pacific Northwest, and determine where improvements could be made. Participants were encouraged to recognize the need to propose realistic recommendations that (1) could be adopted within limits of continued Forest funding constraints, and (2) best improve the value of cultural resource data to the archaeological profession.

Preliminary Comments on Working Group Document Outlines

Following the initial round table discussion, the working groups each presented preliminary outlines of prob-

lems and issues to be considered during their document preparation. During a general comment period following these presentations, remarks were offered pertaining to the important distinction between (1) Forest Service supervision of contract surveys as one opportunity for the calibration or "double blind" testing of survey results prior to impacts, and (2) project monitoring as post-impact re-entry.

Discussion also developed around the question of how useful the working group recommendations would be as guidelines, given the perceived autonomy of Forest personnel and Oregon and Washington State SHPO review processes. It was suggested that considerable use could be made of conference recommendations during formulation of Forest Land Management Plans and by SHPOs.

The suggestion was made that the Forest Service consider "setting aside" land areas with high probability of containing sites (as determined by predictive models) in order to achieve site conservancy. Comment from the Forest Service was that this was contrary to the multiple-use management policy of the agency. Currently site conservancy is achieved through the policy of project avoidance wherein most known sites are avoided by project impacts (estimated more than 95%) while still meeting the multiple use policy.

Concluding Remarks

Following the final presentations of work group recommendations to the Forest Service, a closing discussion period permitted questions and remarks regarding work group recommendations and final comments on the outcome of the conference.

The major question posed concerned the appropriate geographic level at which predictive models should be developed. The recommended answer was that each forest develop one or more models depending on environmental considerations. It was recognized, however, that adjacent forests with similar landforms and settlement patterns would be likely to share models.

Significant discussion centered around the issue of whether archaeological survey had to provide 100% ground coverage. Some participants felt that any inventory providing less than 100% coverage was not adequate to meet the Section 106 requirements of the National Historic Preservation Act. Others felt that an inventory plan designed to find all reasonably locatable sites was adequate for NHPA compliance regardless of the percentage of ground coverage. The presence of various natural and cultural features that preclude ground surface examination was used as a case in support of the latter assumption. Still others felt that until explicitly explanatory models were used to guide inventory, anything less than 100% inventory would result in the loss of sites. Obviously, with these divergent opinions being expressed, no consensus was reached on this issue. However, the participants agreed that further discussion of the topic would be appropriate at professional meetings.

As a concluding statement, it was agreed that the conference objectives were accomplished by the assembled group. The presentations by individual participants, and the work group discussion and recommendations, comprise a significant body of knowledge and opinion that should serve the Forest Service as well as the archaeological profession at large. The group voiced the hope that the summary document would adequately present these data and serve as a springboard for future discussion of inventory efforts in the Pacific Northwest.

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